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THE FLEXIBILITY OF HYDROELECTRIC PLANT CONSTRUCTION.

One of the factors which has contributed most to the successful installation and operation of hydroelectric power plants is a flexibility of design and construction which is frequently illustrated in situations of great engineering difficulty. A fundamental point in favor of hydroelectric supply is the independence of the power-house location with respect to the market for the company's service. With the high voltages now commercially practicable plant location becomes a matter of secondary consequence, and a difference of twenty or thirty miles between station sites on the same or adjacent watershed areas is a small matter. In other words, full advantage may now be taken of purely hydraulic features without imperiling the electrical economy of the system. As the hydraulic end of the problem is almost always the most uncertain and the question of securing an adequate water supply the one accompanied by the largest number of variable factors, it is a great gain to be able to concentrate the engineering talent of the enterprise on this phase of the development, with reasonable assurance that the electrical installation can be fitted to the hydraulic requirements without any serious sacrifice in effectiveness or undue increase in first cost.

In a representative case of this kind the engineers were confronted with the difficult problem of storing the waters of a large river during a season of floods, and as a result of an exhaustive study of the conditions plans were made to build a diversion dam in connection with a chain of lakes and a canal having a total length of about eight miles. Surveys showed that the water could be stored in a lake capable of supplying the hydroelectric plant with enough water to develop about 30,000 horsepower for a period of one month without adding a single drop to the available supply. The storage reservoir is to be formed by building a number of embankments and dams across the mouths of several gullies and small valleys. At the foot of one arm of the lake a suitable location was found for the power house, the site being about 500 feet below the lake level, and permitting an operating head of 440 feet. The flexibility of hydraulic design is further illustrated by the type of dam decided upon at the point of diversion of the water from the river. The dam is to be of the timber crib type, filled

with rock and supported on a concrete foundation, the upper face of the dam being covered with boiler plate to protect it from the erosion of boulders and gravel. The permanent dam has a height of only four feet, and along its top are to be placed sockets in which posts and flash boards can be erected. Arrangement is to be made for cutting iron rods which brace the flash-board posts in case of sudden floods, so that the top portion of the dam will be swept away, leaving a weir opening the full length of the dam, which should be sufficient to allow the escape of any flood without damage to the wing walls of the dam on either side.

In the design of the plant to be built in connection with the above project the engineers have planned to equip the water gates with safety valves which will allow the escape of water should the pressure rise twenty-five per cent above normal, with an additional installation of a stand pipe in each penstock which will take care of any rise or fall in pressure which will interfere with the governing or changes in load in excess of twenty per cent. The standpipes will be extended twenty-five feet above the highest static head of water in the system. With a closing of the turbine gates, in 2.5 seconds the rise of pressure in the pipe line will be about seventy per cent, so that the safety-valve equipment will prevent wasting water except at a time when an entire loss of load occurs. The flexibility of electrical transmission permits the engineers to take full advantage of the natural conditions bearing upon the hydraulic development, and the same benefits apply to nearly every well planned development in which difficulties arise in the design and construction of the water supply.

ATTITUDE OF THE PUBLIC SERVICE COMMISSIONER TOWARD THE CORPORATION.

The address of Public Service Commissioner Edward M. Bassett before the recent meeting of the Brooklyn Section of the National Electric Light Association, referred to upon another page of this issue, is noteworthy because of the attitude which is taken towards the public-utility corporations. It is customary to regard the attitude of these officials as being one of opposition to the acquisition by the corporation of any greater return than that represented by a legal rate of interest upon the capital invested. This attitude, which assumes that the corporation is rendering no more service to the community than the mere supply of capital to conduct its operation is, as pointed out by Mr. Bassett, manifestly unfair. If the officials of a corporation exercise their ability to give better, cheaper and more efficient service, it should certainly be recognized that some of the benefits resulting therefrom should go to the corporation and not the entire benefit to the public, as otherwise there is no incentive for the development of such improved service and only little initiative is likely to be made by the company to accomplish such ends.

It is refreshing to find a recognition of these considerations and a broad-gauged point of view in an official who has to deal with the problems of the regulation of the returns which such public-utility corporations are to receive.

THE PRESIDENT'S MESSAGE.

The recent message from President Taft to the Congress takes up the same view in regard to the subject of conservation that was expressed in his address at St. Paul. This discussion is supplemented by recommendations that the coal deposits, phosphate lands, oil and gas lands and water-power sites be leased by the Federal Government for periods not exceeding fifty years, with stipulations for the payment of rental and the regulation of rates, these to be adjusted every ten years. These recommendations seem to be a reasonable solution of this question in accordance with popular demands, and legislation should be enacted at once so as to permit the development, particularly of the water powers, to be continued without delay. The principle of conservation is being violated so long as these sources of energy remain undeveloped.

In discussing Post-Office matters, the administration recommends that the franking privilege be restricted and that some record be kept of the service which the Post Office Department is rendering other branches of the Government by the use of departmental stamps such as were in use in the seventies. Such an accounting seems very desirable, as a large part of the apparent deficit which yearly confronts us is undoubtedly due to the vast volume of mail matter which is carried without any return. If the deficit can be accounted for in this way there is certainly no excuse for the proposed increase in the rates upon second-class mail. The proposal in the present message is to make a distinction between the advertising and editorial sections of magazines which are mailed at second-class rates. This distinction seems to be based upon the idea that the advertising matter is of value to the advertisers only and does not concern the readers in the same way as the editorial matter. This is undoubtedly a mistaken idea, as large numbers of readers are quite as much interested in the advertising matter and receive quite as many new ideas and benefits from its perusal as from the reading matter. A distinction must be made between this matter, which is received only upon payment of subscriptions, and the advertising matter which is sent out broadcast by itself and is often thrown away by the recipient without more than a glance, because he does not recognize any value in it. The administration maintains that the second-class mail matter is carried at a loss in spite of the fact that the express companies find it profitable to them to carry this matter over a haul of mean length at a lower rate than that charged by the Government. In passing upon this matter, it should also be realized that a great deal of first-class mail matter has its origin in the advertising matter in question.

The introduction of a parcels post in the rural districts is recommended, but the argument that this class of business, like the postal-savings bank, is introducing the Government in a paternal interference with enterprises which ought to be conducted by private persons, is evaded. The establishment is urged not as a feature that the people have a right to, but merely as one of expediency, since the Post Office can carry it on more economically and with less new organization than a private company.

The President recommends physical valuation of railroad property, as already advocated by the Interstate Commerce Commission, as the only proper basis for an equitable regulation of rates. He also urges law to prevent the use of fraudulent bills of lading. The carrying out of these proposals should result in a satisfactory solution of the vexed question of freight rates.

With the above exceptions it is not recommended that any new legislation be enacted respecting interstate commerce, or the trusts. It is specifically recommended that the enforcement of the anti-trust laws should be permitted to go on without modification by new legislation. While this does not mean that prosecutions will not be continued by the executive branch of the Government, it will be a relief to the business interests of the country to know that the present statutes will determine the lawful activities of the large corporations for a number of years, and that they will not be subject to the harassments of new attacks in the shape of radical legislation upon this subject.

The recommendation for simplification of judicial procedure and the expediting of judgments will meet with general favor. Especially in the case of patent litigation is it most desirable that means should be provided for speedy and less expensive decisions than have been habitual in the past. As the President points out, the right of appeal to a higher court has been abused in this country, and should be limited. At present patent suits not only encounter tedious delays, but often involve costs which ruin a patentee of limited means, or else scare him from any effort for the legal protection of his rights. In this connection, attention should be called to the formation during the present year of the Inventors' Guild, mentioned upon another page of this issue, which has as one of its objects the abatement of this deplorable condition of affairs. It is earnestly to be hoped that something may be accomplished in this direction.

ELECTRIC-RAILWAY MILEAGE RATES.

A recent decision of the Massachusetts Board of Railroad Commissioners in a street-railway fare case brought by the town authorities of Abington emphasized a point which it would be well to think over. Incident to sustaining the present rates of the Old Colony Street Railway Company in the Abington-Brockton territory the Commissioners state that "it must be understood that it is practically impossible, in view of local conditions throughout the commonwealth to determine the reasonableness of rates for street railway fares *exclusively upon the proposition of mileage.*" The practice is so general, in the presentation of testimony concerning the reasonableness of street-railway fares, of arguing upon the basis of average rates for passenger-mile that the Board's outspoken limitations of this method of attack ought to do much good. In every public utility the costs of the full service available and as rendered are the crucial points to consider. In the electric-railway field the fare unit buys much more than the mere transportation over a certain distance at a certain arbitrary rate per mile. It buys frequent opportunities to travel on an extended system; helps to maintain transfer facilities; provides standards of comfort which inevitably depend to some degree upon the density of traffic; and above all, it helps pay for a service which can compete with very costly means of private conveyance. In all public-utility rate comparisons discrepancies are likely to appear, but to sift them to the bottom it is necessary to take account of situations as a whole, and not to attempt to determine the reasonableness of charges by a single line of investigation.

ELECTRICAL CHRISTMAS GIFTS.

Those in a position to observe the happenings in the electrical industry realize that this year to a greater extent than ever before, electrical dealers are calling the attention of the public to the desirability and suitability of electrical appliances as Christmas presents. With the more general use of electricity in the home there has followed an opportunity of presenting gifts suitable for either men or women, while there is also now available a large stock of electric toys for the children.

It is true that to a certain extent this opportunity for an electrical participation in holiday trade is met by general merchants and department stores, but central stations and electrical-supply dealers are proving by their consistent efforts that they appreciate this growing demand which could be still further encouraged by judicious publicity. It is not enough that the minds of the public should be directed to electrical appliances at gift-buying seasons, but at all times the advantages of a varied list of electrical conveniences should be pointed out.

Certainly the holiday season forms a particularly appropriate time to call attention to what, to a great majority of the people, are still novelties apparently rather apart from the needs of daily life. By a small amount of effort at this season of the year, when the gift problem is uppermost in the minds of the people, electrical appliances can arrive at the position to which they justly belong. It is to induce the public to consider electrical devices as everyday home comforts and to remove the impression that they are unduly expensive, that the efforts of electrical dealers should be directed.

Annual Meeting of the Electrical Credit Association of Chicago.

The fifteenth annual business meeting of the Electrical Credit Association of Chicago was a notable success. The representatives from the various cities of the middle west and southern states were more numerous than ever before.

The meeting convened at the University Club, Chicago, at 2 o'clock p. m., Wednesday, December 7, President Frank M. Pierce, of the Manhattan Electrical Supply Company, calling the meeting to order.

The president, in his annual report, reviewed the history of the last fifteen years, showing that the Association grew from its charter body of eighteen members to the present number of 210.

The secretary and tresaurer's report showed the total number of claims handled since the organization to be 27,931, aggregating $2,129,459.81; and that of this number, 17,153 had settled, aggregating $1,408,749.84. The average amount collected during the year per each member was $1,075.82. The finances were shown by the Auditing Committee to be in a healthy condition.

The officers elected for the ensuing year are: President, Frank M. Pierce, Manhattan Electrical Supply Company; vice-president, A. O. Kuehmsted, Gregory Electric Company, and two members of the Executive Committee, as follows: E. R. Gilmore, Western Electric Company, and Ivar Hennings, Westinghouse Electric & Manufacturing Company, to serve for a period of three years.

Amendments to by-laws were effected, in accordance with notices previously sent. The amendments, however, did not materially change the workings of the Association, so long in vogue.

Papers were read by the following: Thomas I. Stacey, on "The Executive Committee;" W. S. Thomas, on "What does the Association mean to me?" C. F. Koepge, on "The Inside Workings of our Association;" E. R. Gilmore read a paper prepared by Fred B. Uhrig of Kansas City on "Credits and Collections;" Ivar Hennings, on "The Moral Risk Club of Chicago," and Clyde C. Miner, read a paper on "The Way it Strikes Me."

An open parliament for free discussions on every conceivable subject relating to the Association service and credit and business conditions, was freely indulged in by the several members present.

After the business meeting adjourned at 6:15, and after a recess had been taken, one hundred or more of the gentlemen present sat down to the dinner in College Hall, at which addresses were made by Merritt Starr, Judge Marcus Kavanagh, W. G. McKitterick, Harry A. Antram and others. John F. Gilchrist acted as toastmaster.

Philadelphia Electrical Show.

The Philadelphia 1911 Electrical Show will be held February 13 to 25, inclusive. This show will far excel that of any previous year from every standpoint. The decorative scheme is original in design, and unique in character. Special artists and designers are being employed on this work so that the finished results will be correct in all details, both from an architectural and artistic standpoint.

The space to be sold is limited, and space reservation should be made as early as possible. The management has planned even a broader advertising campaign than last year, specializing particularly to the better class of people in Philadelphia and surrounding territory, comprising somewhat over two and one-half million people.

Chicago Electric Show.

That Chicago is going to have a record-breaking electrical show next month, running from January 7 to January 21, is predicted by its sponsors. Never before in the history of these expositions has there been such an enormously big demand for space, more than ninety per cent of the available floor space in the big Coliseum building having already been sold. The fact that the Electrical Trades Exposition Company is this year sharing a large percentage of the profits with the exhibitors has been much of an inducement in bringing in concerns that have never before taken space in shows of this kind and the list of exhibitors as a whole represents every known branch of the electrical industry and none of the larger concerns are missing.

Preparations have been made to show many absolute novelties and wonders in the way of recent electrical development and invention, including all that is new in wireless telegraphy. Electric cooking will be demonstrated also and the perfected electric telegraph typewriter will be shown.

Manager Homer E. Niesz has received word from Washington that the United States Government will send a large and complete exhibit of everything electrical pertaining to the War, Navy, Post Office, Interior and Treasury Departments. Much of this material formed a part of the recent land show exhibit. It will, however, be augmented by three carloads of other material from the various headquarters at Washington. The electrical show management will devote all of the space in the Coliseum Annex to this combined exhibit.

The officers of the Chicago Electrical Trades Exposition Company for the current year are as follows: Samuel Insull, president; Ellsworth B. Overshiner, first vice-president; Louis A. Ferguson, second vice-president; Stewart Spalding, secretary and treasurer; Samuel Insull, G. H. Atkin, Stewart Spalding, Ellsworth B. Overshiner, George B. Foster, W. W. Low, Louis A. Ferguson, F. V. Bennis and Ed J. Mock, directors; Homer E. Niesz, manager.

Profit Sharing by the Brooklyn Edison Company.

The Edison Electric Illuminating Company, of Brooklyn, has announced through its president, Anthony N. Brady, a profit sharing and pension plan for its employees which goes into operation at once. The announcement says that the directors of the company have authorized the plan "in recognition of faithful and efficient service and for the encouragement of thrift and investment in the securities of the company on the part of the employees."

The plan for profit sharing provides that at the end of the present year employees who have been in the company's service two years shall be credited with a percentage of their pay for 1910 equivalent to one-quarter of the rate of dividends paid on the capital stock during the year, that employees of four years' service shall get a percentage of their pay equivalent to three-quarters of the rate of dividends, and that employees of five years' service or more shall receive a percentage of their wages or salary equivalent of the full rate of the dividends.

Employees sixty-five years of age or over who have been in the company's service for ten years are eligible to a pension.

T. E. Murray.

Thomas Edward Murray, vice-president and general manager of the New York Edison Company, was born in Albany, N. Y., October 21, 1860. He was educated in the public schools and private night schools of his native city, and served an apprenticeship as machinist, after which he spent two years in architectural drawing. After a further shop experience of two years as machinist he became engaged with the Albany Water Works as engineer from 1881 to 1887. During 1887 he was associated with the Albany Electric Illuminating Company as chief engineer, then superintendent, and finally general manager. During this period he also acted for a number of years as consulting engineer for the Albany Street Railway Company, the Troy City Railway Company and the Troy Electric Light Company.

In 1898 he came to New York acting first as consulting engineer of the Kings County Electric Light & Power Company of Brooklyn, N. Y., and on the organization of the New York Gas & Electric Light, Heat & Power Company he became its vice-president and general manager. On the consolidation of the various electric lighting interests in New York under the corporate name of the New York Edison Company, Mr. Murray became second vice-president and general manager, which position he now holds.

THOMAS E. MURRAY,
Vice-President and General Manager, New York Edison Company.

Mr. Murray has also acted as consulting engineer for the Rochester Gas & Electrical Company, Rochester, N. Y.; the Utica Gas & Electric Company, Utica, N. Y.; the Troy Gas & Electric Company, Troy, N. Y.; Edison Illuminating Company, of Brooklyn, and Brooklyn Heights Railroad Company. In these capacities Mr. Murray has designed and been in charge of the consulting engineering and construction work of several of the largest power stations in this country. Mr. Murray's training has been from the ground up and he is thoroughly conversant with the minutiæ of the detail connected with the organization and management of public-service corporations.

In addition to his active service with the New York Edison Company he is connected with a number of other corporations as an officer or director. These include the Citizens Lighting Company of Louisville, Consolidated Telegraph & Electrical Subway Company, the Edison Electric Illuminating Company of Brooklyn, Edison Light & Power Installation Company, Kings County Refrigerating Company, Louisville Lighting Company, Manhattan Electric Light & Power Company, Yonkers Electric Light & Power Company, and Westchester Lighting Company. He is president of the Association of Edison Illuminating Companies.

National Fire Protection Association.

The National Board of Fire Underwriters has recently put forward a plan of unification and consolidation in respect to its fire-prevention engineering activities that will be of striking interest to the underwriting and engineering fraternities alike. It has requested the Natonal Fire Protection Association to take over the work of the two heretofore unaffiliated bodies, the Underwriters' National Electric Association and the Committee of Consulting Engineers of the National Board. The National Board officials have long felt the desirability of unifying the sources from which that body has for so many years drawn its various codes and standards. The National Fire Protection Association has furnished standards for all protective devices and systems; the Consulting Engineers have handled the hazards of gases and oils, and the Underwriters' National Electric Association has been responsible for the National Electrical Code. These three standard-making bodies are now to be merged into one—the National Fire Protection Association; and the work of the two latter bodies, which will cease to exist as detached organizations, will be conducted by special committees of the National Fire Protection Association. The Underwriters' National Electric Association will be entitled the Electrical Committee, and the Consulting Engineers will be called the Committee on Explosives and Combustibles of the National Fire Protection Association. The personnel of the new committees will be identical with that of the two former separate bodies, with the addition to each of one or two desirable members.

The present membership of the electrical committee is as follows:

The Electrical Committee.—F. E. Cabot, chairman; Ralph Sweetland, secretary; William S. Boyd; George E. Bruen; J. E. Cole; Washington Devereux; J. C. Forsyth; C. M. Goddard; C. H. Hill; H. O. Lacount; Charles Lum; A. M. Paddon; Dana Pierce; A. M. Schoen; R. P. Strong; V. H. Tousley; also one member each as representative of the American Institute of Electrical Engineers, American Electric Railway Association, National Electrical Contractors' Association, National Electric Light Association.

Hydroelectric Developments in the West.

To the Editor:

In the paper I presented before the Electric Club, November 9, I should perhaps have mentioned the three power houses on the Kern River; that of the Pacific Light & Power Company having five 3,000-kilowatt generators comes next in size to the Kern River development of the Southern California Edison Company to which I referred, which has four 5,000-kilowatt waterwheel units. There are two large steam-turbine power houses, one owned by the Railway Company and the other by the Southern California Edison Company, each feeding into their respective distribution systems.

In the limited time given me I was unable to describe as much in detail as I should like to have done, the large distribution systems I referred to, and was obliged to omit referring to several other hydroelectric developments which have recently been made.

Chicago, Ill. JAMES LYMAN.

The Inventors' Guild.

In the early part of 1910 several men who had done work along the line of invention, and who, in developing and patenting their inventions, had come to realize the difficulties and disadvantages under which the inventor labors, instituted a movement for the formation of a society looking toward the betterment of these conditions. The result of this movement was the formation and incorporation in New York City of the Inventors' Guild, the object of which is briefly outlined in the followng quotation from the Constitution of the Society:

"The object of the Guild is to advance the application of the useful arts and sciences, to further the interests and secure full acknowledgment and protection for the rights of inventors, to foster social relations among those who have made notable advances in the application of the useful arts and sciences."

Some of the handicaps to which the inventor is subject, other than the proverbial one of never having any money, are the delays in the Patent Office and the ineffectiveness of its work; the expense and tardiness of litigation, and the possibility under which a rich corporation may, by delaying and prolonging a suit, increase the expenses to a point which makes such suits prohibitive for a poor inventor; the disadvantage to which the American inventor is subject in foreign patent offices as compared with the liberality of the United States Patent Office toward the foreign inventor; and many other conditions militating against the American inventor which should be remedied.

The membership of the Inventors' Guild is limited to fifty. The officers are as follows: Ralph D. Mershon, president; Charles W. Hunt, first vice-president; Charles S. Bradley, second vice-president; Thomas Robins, secretary; Henry L. Doherty, treasurer.

Patent Protection Costly to Electrical Manufacturers.

In a recent issue of the Chicago *Tribune*, an interesting résumé appeared concerning the great expenses involved in the protection of patents by electrical manufacturers. The article is as follows:

"About ten years ago Mr. Westinghouse caused a statement to be prepared showing the legal expenses of the protection of his patents from the time he began inventing and marketing electrical apparatus. He was amazed when he saw the total. He passed the paper containing the figures to the present writer [Holland], saying:

"You will see how large an item of expense litigation for the protection of patents is for a manufacturing company like the electrical company of which I am president.

"Mr. Westinghouse was asked if he thought the other great electric corporation, of which Mr. Coffin is president, had been compelled to pay bills of equal, or approximately equal, amounts.

"'His bills must have been large,' Mr. Westinghouse responded.

"It was the contemplation of a sum which of itself would have been regarded as a large capitalization for a corporation, the total expenses of litigation to protect patents, which undoubtedly brought about an understanding between the larger of the electric companies of the United States.

"That agreement provided that each company might use the patents of the other, subject, of course, to a fair royalty. The agreement may be regarded as in restraint of trade, as tending to prevent competition. But that was not the purpose of it. It was entered into simply to put an end to heavy legal expenses.

"Thomas A. Edison had a similar experience. To protect his patents has cost him millions, and although in almost all cases he has received final judgments in his favor, yet many of these judgments were handed down only a few months before the expiration of the patents. In not one instance has Edison ever received a penny representing damages awarded by the courts for the infringement of his patents. This experience has led him to be strongly in favor of the license system, and he has sometimes wondered whether he would not have been better off pecuniarily had he relied upon the trade secret principle for the protection of his inventions.

"Word has come from Washington that the Department of Justice is about to begin proceedings in the federal courts, having for their purpose the dissolution of the so-called electric trust. It will be something of a surprise if the evidence obtained by the government makes it clear that the great electrical companies of the United States are practically operated upon the combination or trust principle. Certainly the competition, at least until within a short time, between them, has been remarkably keen.

"There is still vivid recollection in commercial and railway circles of the fierce competition carried on by the two great electric companies for the contract of electrifying one of the greater railways of southern New Jersey.

"In this city, after the legislature commanded the railroad companies to abandon steam and electrify their terminals, a competition which was scientific as well as theoretic, and in addition practical and financial, was in progress.

"From the scientific point of view this competition involved demonstration of the economy, safety, and expediency of the direct current, which apparatus is controlled by President Coffin's company, and the alternating current, which utilizes inventions of Mr. Westinghouse and his associates. The New York Central Railroad accepted the propositions made by President Coffin. The New Haven railroad preferred the alternating current and the apparatus for using it. The struggle was a desperate one. In it is not to be found any evidence of such a combination as the attorney general might reasonably regard as having been forced in violation of the anti-trust law.

"So far as the public knows, the only combination entered into between the greater electric companies in one involving a common use of patents upon payment of royalties. Apparently the Department of Justice deems it worth while to test in the courts whether or not a monopoly secured by patent may be so used to justify the allegation that this is done in violation of the anti-trust law.

"Should the courts so find, then a new and unexpected issue will have been created. It might be so extended as to include some of the companies operated under the Edison patents. It would almost appear to invalidate the license system, certainly if the system gave exclusive right to one corporation within a certain district, to operate under patents controlled by another corporation. So far as now can be seen, the question involving proceedings against the so-called electric trust is simply this: Must a corporation that controls a patent be compelled to make exclusive use of that patent in its own manufactory? For it is thought to be apparent that the Department of Justice does not purpose attacking the monopoly itself, which is the vital quality of a patent."

Chicago Railway Merger.

The Chicago Railways Company has accepted the ordinance granting it permission to absorb the Consolidated Traction Company, and extending its franchise over the lines of that company. The document formally accepting the ordinance was signed by the officers of the Railways Company, authorized by act of the board of directors, and also by the federal receivers.

Accompanying the formal notice of acceptance was a certificate from the board of supervising engineers certifying that the Railways Company has arranged to operate 215 pay-as-you-enter type of cars on the Consolidated lines, as required in the ordinance of rehabilitation, as rapidly as possible.

The Municipal Building at Washington.

The Electrical Installation in the Administration Building of the District of Columbia.

In keeping with other recently constructed government and city buildings in the National Capital, the new Municipal Building of Washington, D. C., is a most striking example of the high status of present-day architecture. Situated on famous Pennsylvania Avenue, between the United States Capitol and Treasury buildings, this imposing structure lies in the path of thousands of admiring visitors to the Capital City, who are unanimous in conceding it one of the most impressive of Washington's public buildings. An idea of the general appearance of the building may be gained from one of the accompanying illustrations.

THE MUNICIPAL BUILDING, WASHINGTON, D. C.

In addition to being a handsome office building, in which the affairs of the District of Columbia are conducted, the Municipal Building is provided with every convenience known to modern engineering. For the proper heating, or cooling, of the offices a combined heating and ventilating plant has been installed, which is a model of its kind. The temperature of any room or section of the building may be automatically kept at a given temperature throughout the entire year. To make for speed and accuracy in dispatching orders, mail, etc., to all departments there is installed a unique and efficient pneumatic system. Iced drinking water is piped to every floor and every office in the building. In the operation of these and other systems installed in the building electricity plays an important part, and a consideration of the electrical equipment may prove of interest.

For supplying light, heat and power to the Municipal Building, there is provided in the basement a power plant, complete in every detail. The plant is divided into an electric generating room, a boiler room, a pump room and other rooms in which the elevator motors, refrigerating machinery and miscellaneous equipment are installed.

The boiler room is located in a sub-basement on a level about eighteen feet below the engine-room floor. The equipment in this room comprises four 150-horsepower Stirling water-tube boilers arranged in a single row in two batteries of two boilers each. A view of these boilers is shown in one

of the accompanying illustrations. They are of such design and size as to give necessary room for firing and for the removal, cleaning and replacing of tubes. As may be seen from the illustration, the boilers are substantially set in brick work, and each battery is equipped with a damper regulator for automatic regulation.

Each boiler has a heating surface of 1,750 square feet and is guaranteed to give an equivalent evaporation of not less than nine and one-half pounds of water per pound of dry anthracite coal fired when run at not less than its rated horsepower, and to be capable of forcing to twenty per cent above rating. Steam is maintained at a pressure of 125 pounds per square inch.

Coal is brought to the furnaces in industrial cars from the coal bunkers, and in this manner the ashes are also removed to a hydraulic ash hoist, which raises the cars to the street level, where they are dumped into wagons.

The steam piping comprises a six-inch main header in front of the row of boilers, to which lines are connected from each of the boilers. These connections curve over the tops of the boilers, making a ninety-degree bend. The main header is looped to the engine room, where connections are made to each engine. A branch line is run from the engine-room header to the pumps and auxiliary apparatus, which are located on the same level as the boilers. The engine-room piping is so arranged that the cutting-out of service of any boiler or either battery of two boilers will not interfere with the operation of the plant.

The engines discharge into a ten-inch exhaust header, which connects with two sheet-steel exhaust mufflers and oil separators located on each side of the engine room. After the oil has been separated from this exhaust steam it is conveyed to the hot-water heater and main heating coils. In summer, when the heating system is not in operation, all excess exhaust steam is passed to atmosphere.

All high-pressure steam piping is of extra-heavy wrought iron with heavy cast-iron fittings. The exhaust-steam lines are of standard wrought iron with standard cast-iron fittings. The entire system of high-pressure piping and fittings was subjected to a hydrostatic test of 250 pounds per square inch before acceptance.

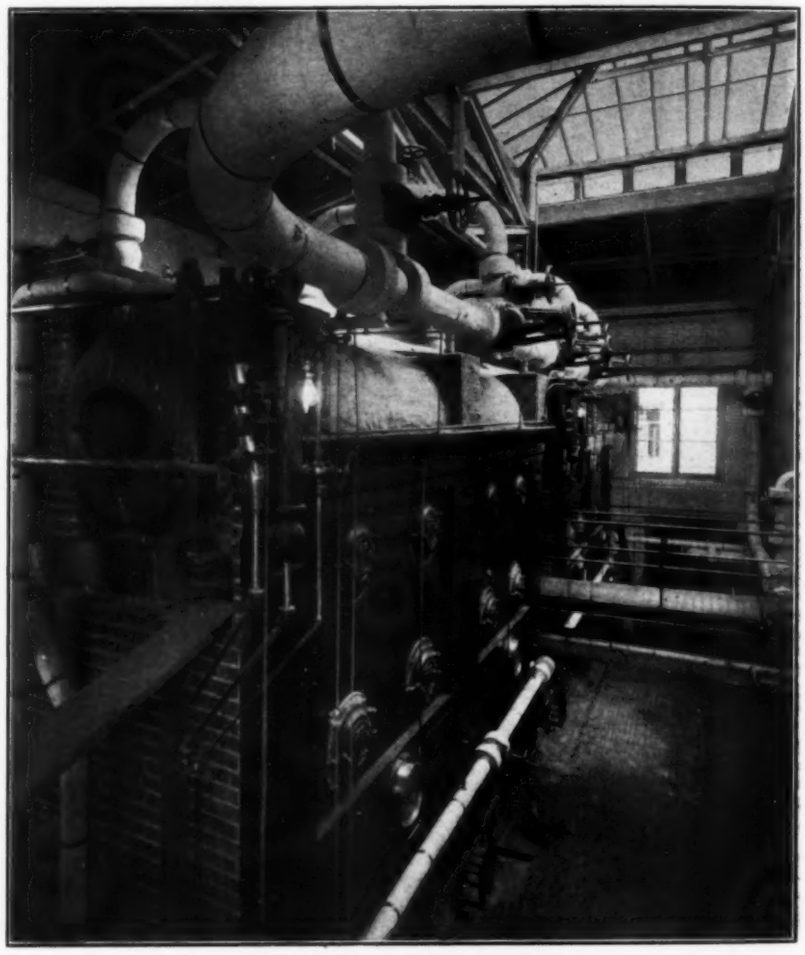
The boiler-feed line is of brass pipe and forms a complete loop to the boilers. An emergency connection is made with the house-service supply at the east end of the loop. Special controlling valves are placed at each boiler, located at a convenient height above the boiler-room floor.

Water is obtained from two six-inch cast-iron mains, entering the plant near the ash hoist. The main supply is drawn through a six-inch balanced valve discharging into an open tank and controlled by a copper float in the tank. From this tank there is an eight-inch outlet to the fire pumps and a four-inch outlet to the suction lines to the house pumps, boiler-feed pumps, etc. There is also a four-inch by-pass line around the tank.

The water heater is located west of the boilers and is of the vertical cylindrical type, with an internal heating coil of 300 gallons capacity. This heater is arranged to use high-pressure steam from the boilers and is equipped with reducing valves and thermostat control.

The equipment of pumps in the Municipal Building power plant is all installed in duplicate, one set being operated by steam engines and one set by electric motors. There are two boiler-feed pumps, vacuum pumps, two house-service pumps, two sump pumps, two fire pumps, one ammonia pump, and one circulating pump for the ice water installed.

The boiler-feed pumps are 6 by 4 by 6-inch duplex pumps of the vertical marine type. There is furnished one 6 by 4 by 6 duplex steam pump and one electrically-driven 5 by 6 triplex for house service. These pumps work against a total head of about forty-three pounds per square inch. The house-service pumps are designed to pump into a series of roof tanks, each of which is equipped with an upper or lower-limit adjustable float switch, so connected as to automatically stop and start both the steam and electric



GENERAL VIEW OF BOILER ROOM.

pumps, according to the height of water in the tanks. The electrically-driven house pump is operated by a five-horsepower motor.

The sump pumps, for lifting water from sump and forcing it to the sewer drain, comprise a 10 by 6 by 12 duplex steam pump and one electrically-driven 8 by 10 triplex pump. These pumps are furnished with automatic control, operated by water level in the sump pit. The motor for operating the electrically-driven sump pump is of seven-and-one-half-horsepower size.

The Underwriters' fire pump installed is 14 by 7 by 12 in size and is connected to the city water mains. This pump discharges into a five-inch main, which is run throughout the building independently of any other system of piping. The pump for circulating the ice water to all departments of the building is driven by a two-horsepower motor.

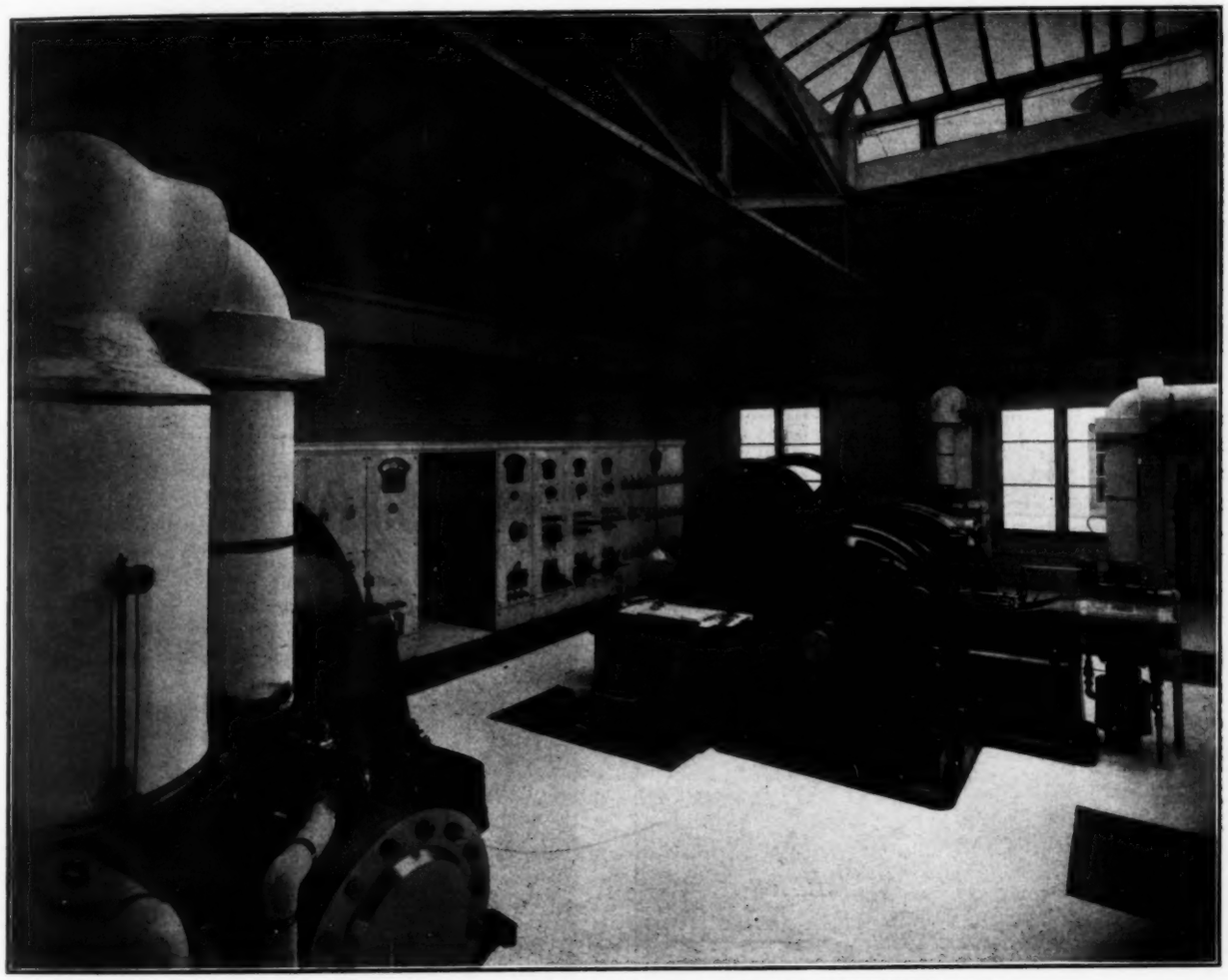
The engine room of the Municipal Building is situated just south of the boiler room in such a position as to receive natural light on two sides. The interior is finished in white-enamel brick, making the room sufficiently light during the day to obviate the necessity of artificial illuminants.

The generating equipment comprises two Ames 16 by 18 and one 13 by 12 engines direct connected to two 150-kilowatt and one seventy-five-kilowatt direct-current generators. The two 150-kilowatt machines operate at a speed of 220 revolutions per minute and the seventy-five-kilowatt generator operates at a speed of 275 revolutions per minute. The indicated horsepower of the engines is 230 and 120 respectively.

The generators are compound wound and operate in multiple. They are wound to give 225 volts at no load and 240 volts at rated full load. The series winding of the seventy-five-kilowatt generator is so proportioned that it may be thrown in multiple with the larger generators. The generator leads from the two larger machines to the switchboard are 1,200,000 circular mils cross section and the seventy-five-kilowatt generator leads are of 600,000 circular mils cross section.

The main switchboard is located adjacent to the southern wall of the engine room and is divided into two sections, with a four-foot passage between them. It is of white Italian marble and comprises fourteen panels, each 2 feet 3 inches wide and 7 feet 6 inches high. When facing the board the section to the left is for controlling the power circuits, while the section on the right controls the lighting circuits.

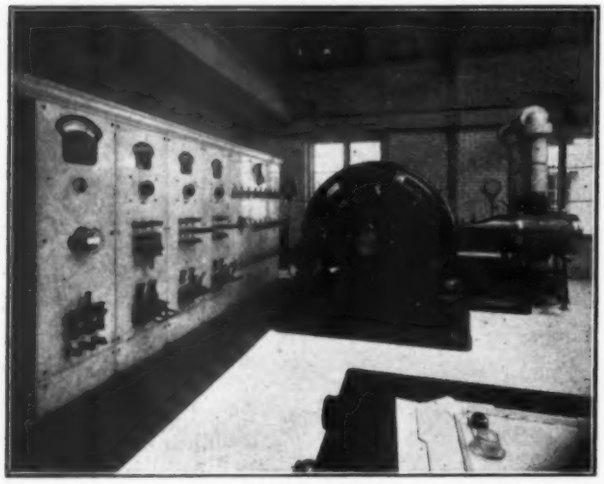
Starting with the extreme left panel, when facing the board, the first three are blank, but will later be equipped as storage battery panels; the next four are motor panels, and are equipped with a Weston station voltmeter and a Bristol recording voltmeter in addition



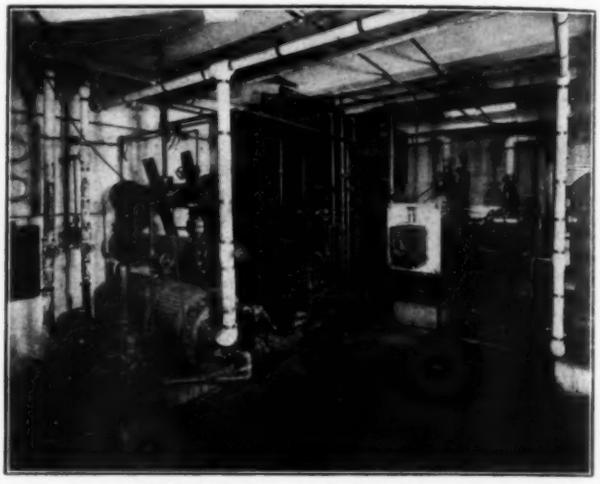
GENERAL VIEW OF POWER PLANT, MUNICIPAL BUILDING, WASHINGTON, D. C.

to the standard equipment of switches.

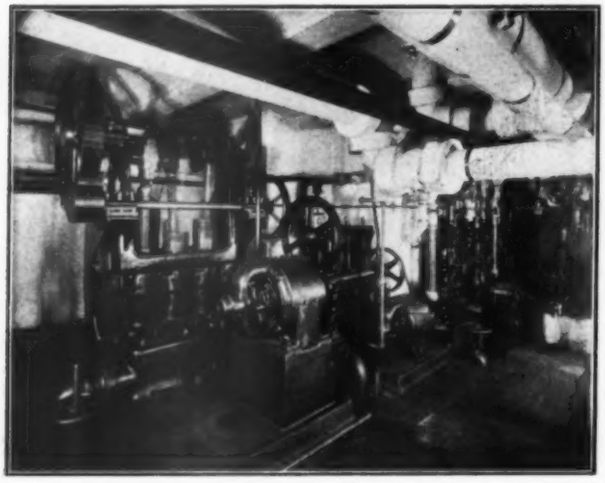
The first panel of the second section is termed the "tie-switch panel" and is equipped with necessary switches for reversing the lighting and power circuits. This panel also contains a Thomson direct-reading astatic wattmeter of 6,000 amperes capacity, for measuring the total power supplied to the motor circuits, and one for measuring the total power supplied to the lighting circuits. The next three panels are the machine panels, equipped with Weston ammeters, and the last three are the lighting panels.



GENERATING UNIT AND HALF OF SWITCHBOARD.



AIR COMPRESSOR AND DRINKING-WATER PLANT.



VIEW OF PUMPS.

VIEW OF ELEVATOR MACHINES.

There are two sets of busbars, one for the lighting circuits and one for the power circuits. The equalizer bar extends from the cross-connecting switch to each of the generator switches. The switches controlling the elevator-motor circuits are connected to a separate set of busbars from those controlling the other motor circuits. All wiring through the building is run in iron conduit.

The elevator installation in the Municipal Building comprises seven electric elevators, six for passenger service and one for freight service. The lifting capacity of the passenger elevators is 3,000 pounds and of the freight elevator 3,500 pounds. The elevator mechanism is of the tandem worm-gear type, having motor and machine mounted complete on the same bed plate. Each machine has a drum of forty-two inches. The motors for operating the elevators are of fifty horsepower size and are compound-wound machines of the slow-speed multipolar type.

Each elevator is controlled by means of an up-and-down automatic stop switch, placed in the car giving the conductor full control of speed and direction of movement. Provision is also made to operate the car from the elevator switchboard, the control being so arranged that when the elevator is being operated in the car the switchboard control is cut-out and *vice versa*.

The passenger elevators are arranged in banks of three, one bank on each side of the building. Directly under them, in the basement, are the machines and motors. There is for each bank of elevators a single-panel switchboard for controlling the motors. Each elevator is equipped with a complete Armstrong electric-signal system. Each elevator is also provided with a telephone which connects with the power plant so that trouble can be immediately reported.

The heating and ventilating system is a feature of the Municipal Building. Air enters the sub-basement from the inner court through three fresh-air

chambers where it is washed and conveyed to heaters. A parallel system of ducts conveys washed air to cooling chambers and at the division points for the air ducts for each room there are installed mixing dampers for controlling the temperature of the air admitted to the tempered-air ducts. For the automatic control of these dampers there is installed a system of automatic temperature control complete in every respect.

The system consists of thermostats in the various rooms, controlling the mixing dampers at the base of the heat flues, and a system of air piping of galvanized iron, together with a water-driven aid compressor, automatic in its action, equipped with an air reservoir.

The thermostats operate their respective dampers with a graduated action, placing the dampers in such a position as to allow the proper amounts of hot and tempered air to pass through them simultaneously to maintain the desired temperature in the room. These dampers remain in this position as long as the temperature of the room remains constant, moving to a new position only when a new proportion of hot and tempered air is required to maintain the desired temperature.

For supplying this air to the various parts of the building, there is installed in the basement three large blower fans, each operated by a twenty-five-horsepower shunt-wound motor. These three fans operate at a speed of 200 revolutions per minute. There are placed in each room and in the corridors foul air vents which empty into ducts convey the foul air to the vent chimneys. For exhausting this air there are installed in the attic six motor-driven exhaust fans, two operated by two-and-one-half-horsepower motors, two by two-horsepower motors and two by one-horsepower motors.

As previously mentioned, cold drinking water is piped to all parts of the building and in accordance with this there is installed a complete cold drinking-water plant consisting of an ammonia generator, an absorber, an ammonia pump and a circulating pump. For operating the latter, which is a three by four-inch vertical triplex pump, a direct-connected two-horsepower motor is employed. The ammonia pump is steam-driven.

CENTRAL TUBE STATION, MUNICIPAL BUILDING.

For dispatching orders, mail reports, etc., from various departments to other departments a pneumatic-tube system consisting of one central exchange, one branch exchange, six double stations and twenty-nine single stations is employed. A view of the central exchange is shown in one of the accompanying illustrations.

Compressed air is furnished by a steam-driven duplex nine by eleven by fourteen air compressor, with automatic governor and control located in the basement. A storage tank located adjacent to the compressor is connected by pressure regulators for reducing the pressure in the tank to twenty pounds gauge. The carriers are operated at a speed of twenty-five feet per second.

The lighting of the Municipal Building conforms to the latest practice. General lighting in the various offices is accomplished by means of clusters of tungsten-filament lamps, this being augmented by wall and desk lamps installed in convenient places. The corridors are all lighted by high candle-power tungsten-filament lamps inclosed in glass globes. All lighting circuits are wired for 220 volts.

The power plant in the Municipal Building is in charge of W. D. Hamilton, chief engineer.

Changes in the Electrical Rules and Regulations, New York City.

Beginning December 15, 1910, Rule 31-C of the Bureau of Electrical Inspection, Department of Water Supply, Gas and Electricity, New York City, applying to garages, will read as follows:

A garage is that portion of a building in which any automobile carrying volatile inflammable liquid is kept, whether such automobile be kept for use, for sale, for rental, for exhibition or for demonstrating purposes, and all that portion of a building that is on or below the floor or floors on which an automobile carrying volatile inflammable liquid is kept and is not separated therefrom by tight unpierced fire walls and floors.

a. Approved metal conduit or approved armored cable must be employed.

b. Cutouts, switches, receptacles and sockets, which are permanently located must be placed four feet above the floor.

c. Switchboards and charging panels, if not placed four feet above the floor, must be located in a room or enclosure provided for the purpose.

d. For portable lights, flexible cable designed for rough usage must be employed, this cable carrying the male end of a pin-plug connector or equivalent of at least three amperes capacity, the female end being of such design or so hung that the connector will break apart readily at any position of the strained cable. The connector must be kept at least four feet above the floor. For all portable lights, keyless molded-mica or metal-sheathed porcelain sockets equipped with handle, hook and guard must be employed.

e. For charging, theater stage cable must be employed, this cable carrying the female end of a pin-plug connector or equivalent of a capacity of at least fifty amperes, the male end being of such design or so hung that the connector will break apart readily at any position of the strained cable. The connector must be kept at least four feet above the floor, and the male end, if not located on a switchboard or charging panel, must be shielded against contact.

f. Motors, if not located at least four feet above the floor, must be of the fully inclosed type, or must be inclosed in an approved isolated fireproof room.

TESTING STEAM TURBINES AND TURBOGENERATORS.

MEETING OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 254th meeting of the American Institute of Electrical Engineers was held in New York City on December 9, with President D. C. Jackson in the chair. The paper of the evening was on "Testing Steam Turbines and Steam Turbogenerators," by E. D. Dickinson and L. T. Robinson.

The purpose of the authors is to outline the precautions which should be taken in determining the efficiencies of turbogenerator plants and to consider the relative degrees of accuracy of different methods. The over-all economy or efficiency of the complete unit is the thing of commercial importance, although individual tests are of interest. Testing by allowing for the different losses, so commonly employed for electrical apparatus, is inadmissible. The one positive method of test is to measure the steam input and electrical output. The surest method for steam consumption is to condense and weigh the steam. This requires that no extraneous steam be allowed to enter the condenser. Leakage in the condenser is a common source of error, and should be checked before and after each test by running with full vacuum and measuring the discharge from the hot-well pump. Split tubes sometimes open up only when heated by a heavy flow of steam, and the leakage test does not disclose the trouble, but it is evidenced by erratic results. When the condensed steam cannot be measured, as in non-condensing turbines, or with jet condensers, the boiler feed water may be weighed, but this method is subject to large errors. Valves cannot be relied on to be tight, and piping must be disconnected. Leakage in the boiler itself is difficult to locate, but should be checked by closing the throttle. Leaks of ten per cent are common. The test by heat balance, or measuring the heat transferred to the cooling water from the condensed steam, is unreliable, owing to the difficulty of measuring the quantity of cooling water and the true average temperature. Tests should be run with fixed conditions after equilibrium has been reached. The quality, pressure and temperature of the entering steam must be known, also the exhaust pressure. A vacuum gauge is not reliable for the latter, but a mercury column should be used. The electric output used should be net, that is, kilowatts for excitation should be deducted from generator output. All instruments should be calibrated before and after the test. Before starting, the turbine should be inspected, and the interior examined to see that the buckets have not been damaged. Any necessary adjustments should be made before testing, and not altered afterward. Turbines should be tested under the conditions of operation, as corrections for conditions are objectionable and vary with different machines. The corrections for steam pressure, moisture and superheat are less liable to mislead than that for varying vacuum. Steam may be measured by meter with proper precautions, and is a valuable check in any case.

The electrical output should not be measured with switchboard instruments. Direct current should be measured with shunts giving 200 millivolts drop, and portable instruments should be generally used. Stray fields must be avoided, and the errors of shunts watched, such as distribution of current and thermal effects. If instrument transformers are used for alternating current, their calibration must be known for the conditions of use. A test should be made on non-inductive load when possible, and the voltmeters and ammeters are then a check on the wattmeters. The use of watt-hour meters should be avoided, since these are inferior to the best indicating meters. If the load is very fluctuating the watt-hour meters may be preferable, and if used they should be checked at the frequency, voltage, wave form, etc., used in testing. Single-phase instruments are to be preferred to polyphase instruments.

The discussion was opened by Gano Dunn, who dwelt upon the importance of the detail tests of the parts of the unit. Experience in the design of ordinary generators does not suffice for the problems involved with high speeds. It is desirable to know the proportion of losses chargeable to the separate elements, these being quite different from the values at low speeds. He referred to the question of mechanical balance, and the difference in balancing according to whether the critical speed, at which rotation takes place about the center of gravity, be exceeded or not.

W. L. R. Emmet referred to the difficulty of separating the various losses, and regarded the net result as the thing of importance to both engineer and purchaser. It would be desirable to test the generator separately, but it cannot well be run by anything but the turbine which drives it. One method of carrying on such a test is the retardation method.[1] The losses in high-speed generators are larger than usually supposed, and detailed lists of losses should be accepted with caution. The windage losses especially are large and vary greatly. He then referred to the steam meter as a valuable piece of apparatus, and checks by weighing condensed water had shown it reliable to two per cent and generally in agreement to one-half per cent. Even if not relied upon, it will frequently disclose sources of error, such as a leaking condenser.

Francis Hodgkinson thought one hour sufficient for an accurate test since longer tests would agree in successive hours. Still he did not advocate such a short test. He referred to a hydraulic brake which he had devised for testing turbines separately, thus eliminating electrical measurements and permitting steady conditions to be more quickly attained. He also spoke of the corrections for vacuum, and the desirability of testing under different degrees of vacuum and different loads.

W. L. Robb differed from the authors on a few points.

He agreed that the steam conditions during test should be as nearly as possible the conditions under which the turbine is normally to operate in service; but he would have the generator loaded during test with a load of approximately the same power-factor that will be met with in the normal operation of the plant. Such a load will be the one most easily obtained for the test under ordinary circumstances. All instruments on whose readings the calculation of efficiency are finally based, should be calibrated before and after the test, not excepting series transformers. Neither steam-flow meters nor watt-hour meters should be used as a basis for the final calculation of the efficiency of the set. It will be found convenient, however, to have both instruments in service at the time of the test. Frequently some irregularity in operation or in conditions of test will be indicated more promptly by these instruments than from the periodic readings of the indicating wattmeters and the weights of steam. At the completion of test, data will be available for determining the accuracy of the steam-flow and watt-hour meters. The time to prepare for a test is before the tubrogenerator and its auxiliary apparatus, including steam piping and switchboard, are installed. A few extra valves of relatively small cost will greatly facilitate blanking off the apparatus under test from the rest of the power-house equipment, and no test is worthy of the name if reliance is placed on all valves being tight. Little, if any, attention is usually given in switchboard design, to making provision for the introduction in the circuits of standard series transformers or instruments, either for use in efficiency tests or in calibration of switchboard instruments. A slight and inexpensive change in the design of the disconnecting switches now commonly installed would greatly facilitate the use of standard instruments at times when their use is desirable. Measurements of feed-water are unreliable, as the quantity of water in the boiler is usually determined by the height of water in the gauge. The height of water in the gauge is not only a function of the quantity or weight of water in the boiler, but also of the temperature of the water and the rate and point from which the steam is taken from the drum. It is convenient during test to work up data as rapidly as possible, to enable one to plot the steam flow as a function of the kilowatt output, selecting scales that give approximately a forty-five-degree slope to the line. Any irregularities occurring during test, such as abnormal leakage in the condenser, will be apparent in irregularities in the points of this line, and much time will be saved in removing the causes of these irregularities. It is good practice to work out the results to be obtained from observations every fifteen minutes and to eliminate in the final calculation all observations taken before the results obtained for successive intervals became uniform. This has usually meant the elimination of the observations taken during the first hour, and sometimes during the first two hours. A run of one hour after the conditions have become constant will give sufficient data for a calculation of the efficiency, provided a surface condenser is used.

E. D. Dreyfus stated that there are over 2,000 steam turbines in operation in this country and he thought sufficient experience had been had to determine

1. This method was fully described in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for August 27, 1910, page 415.

the performance within very small limits of error. He cited cases where separate tests had been made electrically and with hydraulic brake and excellent agreement obtained. He uses one-half the thoeretical value as a correction factor for pressure.

W. C. L. Eglin spoke from the standpoint of the operating engineer. He did not consider the acceptance test of any value unless made in the manufacturer's plant, where better conditions can be obtained. It is difficult there however to get unity power-factor, and to get trained observers. He had found the steam-flow meter accurate, and by its use changes in turbine efficiency had been promptly discovered. He preferred tests covering long periods.

C. O. Mailloux spoke of the advisability of segregating the tests of the two parts, as without it the turbine designer blamed the generator for poor performance and the electrical designer blamed the turbine. He agreed with Professor Robb as to short tests. He objected to the use of the word "deceleration" for retardation, by a previous speaker, and the secretary and J. M. Knox spoke in similar vein.

A. H. Pikler considered a watt-hour meter necessary and advised an indicating meter to check it.

E. B. Rosa spoke of electrical measuring instruments and the reliability of both series and potential transformers after proper calibration. Their calibration is more permanent than that of the instruments used with them. Shunts are particularly liable to introduce errors and should be tested before use, and not merely after use.

L. T. Robinson answered some of the criticisms which had been made and E. D. Dickinson closed the discussion. He said the steam-flow meter had been used for long periods without losing accuracy, but a small error will sometimes arise due to a small hole in the nozzle becoming clogged.

BANQUET OF THE COMMONWEALTH EDISON SECTION, NATIONAL ELECTRIC LIGHT ASSOCIATION.

Commonwealth Edison Section of the National Electric Light Association.

The accompanying illustration shows the Commonwealth Edison Section of the National Electric Light Association holding its annual banquet in the Gold Room of the Congress Hotel, Chicago, on November 1. Over 450 members and guests were present and a very enjoyable evening was spent. An account of this affair appeared in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for November 12, on page 972.

Electrical League of Cleveland.

The Electrical League of Cleveland held a meeting on December 6 for the election of officers, and this was followed by a turkey dinner. There were forty-two in attendance. The newly elected officers are: President, H. H. Cudmore, of the Brilliant Electric Company; vice-presidents, E. E. Noble, of the Illuminating Company, C. T. McKinstry, of the Erner Electric Company, and A. L. Oppenheimer, of the Enterprise Electrical Company; secretary-treasurer, T. P. Cagwin, of the Cleveland Telephone Company; executive board, H. E. Hackenberg, of the National Carbon Company; G. S. Milner, of the Erner Electric Company; J. T. Kermode, of the Illuminating Company, and J. Robert Crouse, of the National Electric Lamp Association.

THE FINANCIAL ASPECT OF WATER POWERS. [1]

BY R. C. BEARDSLEY.

It has been asserted that owing to the great first cost of water powers they were seriously handicapped and instances have frequently been given where this first cost ran as high as $300 per horsepower of turbine. As the cost of machinery, even for a low-head water power should not exceed $35, and for a high-head power with a capacity of several thousand kilowatts not over $23 per horsepower, why such excessive costs? It must be due either to one or more of the following reasons: careless engineering; the desire to increase the total income at the expense of the *rate* of profit; the obstacles inherent to the locality.

Economically, that investment should be best which returns the largest *rate* of dividends, but it is business policy to develop to a point, beyond which the dividends will be unsatisfactory. It cannot be disputed that every water power has a certain development at which it will return a much higher rate of dividends than it will if developed to the usual limit. Thus the highest rate may usually be derived when the development is based on the minimum flow, and usually on the static head which is the cheapest per foot of fall. Yet this development is seldom advocated. Having possession of a water power the owner wishes to develop to the limit so as to make the proposition one of some magnitude, otherwise he knows that later on he will be compelled, at greatly added expense, to complete the development. A steam plant is not developed in this way. Owing to its nature, an increase in capacity at any time is a comparatively simple matter. The steam engineer may be tempted to over-develop by installing a plant too large for the market and to introduce too many refinements, thus increasing the cost of the output. Both plants should be developed on the same basis to the end that the cost of a kilowatt-hour delivered to the customer will be a minimum.

Note, however, the difference. While the steam plant is developed to take care of the given market at the lowest cost per unit of output, the water power is developed to that point beyond which it will be cheaper to install fuel power. The larger the steam plant, the more cheaply can it generate, but beyond a certain point, which is usually passed, the cost of the water-power output increases. Hence, it will be seen that a prevalence of high costs for water-power plants is proof of their financial superiority in operating, over the fuel plant.

Take, for example, the Niagara Falls plant. A simple development there need not cost to exceed $35 per horsepower for the machinery, pipes, head works and power house, and yet these developments, it is claimed, cost about $100. Granite power houses were built and expensive tunnels and head races constructed. The reason was that the investors wished to develop 100,000 horsepower and make the proposition one commensurate with their ideas of size. The investor could have built a number of small cheaply developed plants which would have aggregated 100,000 horsepower and netted much larger returns, especially as the large output greatly reduced the charges for power, but this would have scattered the investment. Hence the Niagara development marks what the investors considered the economic limit. Then there have been other plants built where all three of the above agencies have played a part, resulting, possibly, in a $300 plant.

With these causes in mind, how unfair it is to condemn water powers in general because of such excessive first cost in certain cases. The average water power may, in nearly every case, have a lower first cost than any other form of power plant, and if its cost is made to exceed such sum, it is only because the investor believes it to be to his advantage to so increase it, and in every case the cost of output should be less.

Table I gives the cost of recent water powers built by the writer or estimated carefully from working plans. The first four were actually built, and it is to these four plants that particular attention is called. Each plant was constructed of reinforced concrete throughout. The dams are of the buttressed gravity type. All head gates are lifted by motors, traveling cranes are installed, and all machinery is as good as should be desired. The cost covers every item up to the transmission line, except lands and water rights, and it will be noted that about $52 per horsepower of turbine installed is the average cost for moderately low heads. At Leavittsburg the low head caused a higher cost, while at Charles City, a penstock costing $26.6 per horsepower, and the small size of plant is responsible.

To place the water power on the same basis, for comparative purposes, with the fuel plant, the cost of the transmission line and the substation must be added to the cost of the water-power plant; and the peak-load capacity of the water power must be compared with the peak-load capacity of the steam plant.

TABLE I. PLANTS BUILT OR ESTIMATED CLOSELY.

Reinforced concrete construction. No lands or water rights. Plants complete to high-tension transmission.
Attendance charge taken at $2000 per year for the smallest plant which is rather high.
40-year replacement fund allowed for on total development.
Interest at 6 per cent.
Maintenance at 3 per cent on total physical cost.
Administration allowance is about $3 per horsepower delivered to the line.
Taxes at 105.
Oil, waste and small tools 40 cents per horsepower.

Name or Location	Head in feet	Net horse-power at turbine	Cost per horse-power at turbine shaft	Operation cost per net horsepower delivered to the high-tension transmission. 24-hour operation
Newton Falls,O.(Porter)	18	1000	$47.00	$ 9.05
Newton Falls,O.(Lowry)	16	1000	52.00	9.68
Leavittsburg, O.	9	500	88.00	17.30
Charles City, Ia. (1)....	13	300	100.00	23.20
Parkman, O. 2 plants (2)	50&60	600	53.00	9.00
Greenfield, O. (3).....	106	20000	85.00	
Hickory, N. C.....	45	16000	40.50	
New York No. 1 (4)....	30	1600	109.80	
New York, No. 2 (5)...	39	1600	85.70	
New York No. 3 (6)....	185	12000	66.00	

1. 1100 feet penstock cost $26.6 per horse-power.
2. 2 dams 1.2000-foot 39-inch steam pipe canal and reservoir.
3. 2-68 foot dams, tunnel 5000 feet.
4. Earth dam.
5. Earth dam and 4000 by 8 feet penstock.
6. Earth dam and two 12,000 by 9 feet penstock.

Thus, as Mr. Stott has pointed out, a steam turbine can, with practically no additional cost for turbines, be made to carry a 100-per-cent overload. The generators and all other equipment will, however, be increased 33 per cent as the usual overload capacity of generators, etc., is 50 per cent. Taking the cost of steam turbines at $25, and the total cost of steam plant at $90, the peak load of 100 per cent will cost $111 per nominal horsepower of turbine, or putting it another way, $55 per peak horsepower. This is favorable to the steam plant as frequently the overload rating of the generators is but 25 per cent. Therefore, for a fair comparison of first costs, the water power must have a 100-per-cent overload capacity. Based on water-wheel rating we will assume that it has no overload capacity at all and additional wheels must be installed. It then becmes a question of what such additional wheels, with the

1 Paper read at a meeting of the Cleveland Section, American Institute of Electrical Engineers.

necessary settings, cost. Figs 1, 2, 3 and 4 give the cost of the various water turbines and impulse wheels. Even in the case of low heads and open settings the concrete wheel pits are not the most important item, as at times of peak load a much higher, say 100 per cent higher, two dollars per horsepower, increasing the electrical equipment nine dollars, and the hydraulic machinery ten dollars, making the total cost of the Lowry plant $73 per horsepower, or $36.50 per peak horsepower.

In large high-head water powers use the horsepower of the water plant must be based on the condition of *minimum head* as well as *minimum flow*, if a fair comparison is to be made with the fuel plant. Usually low-head plants are subject to back-water troubles, in which case sufficient turbines must be installed

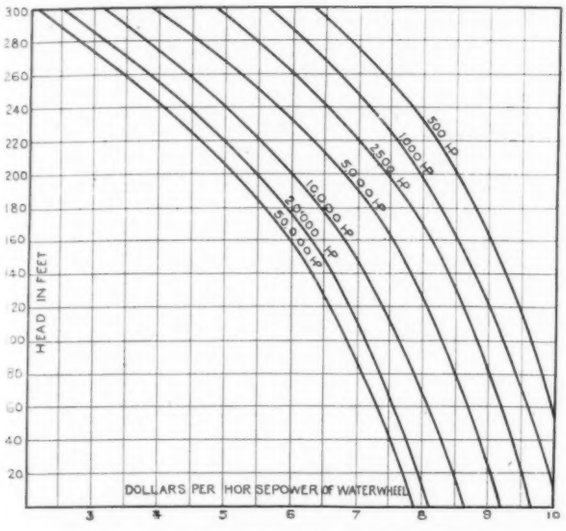


FIG. 1.—COST OF REACTION WATER WHEELS.

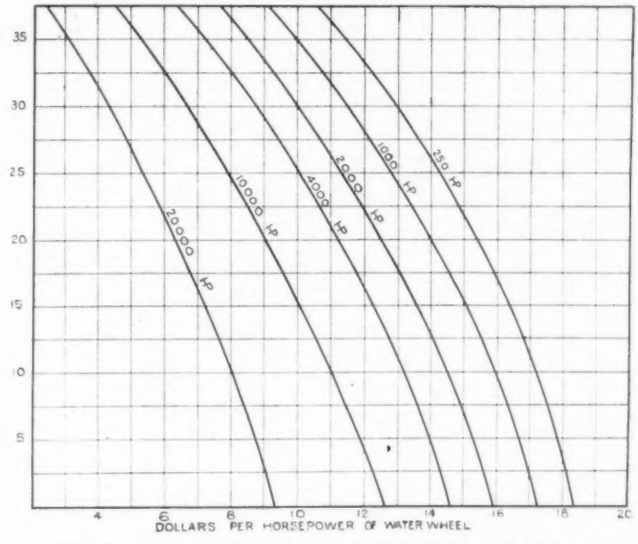


FIG. 2.—COST OF VERTICAL GEARED WATER WHEELS.

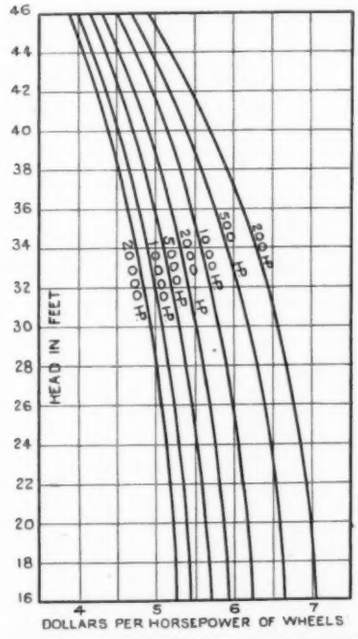


FIG. 3.—COST OF HORIZONTAL OPEN-SETTING WATER WHEELS.

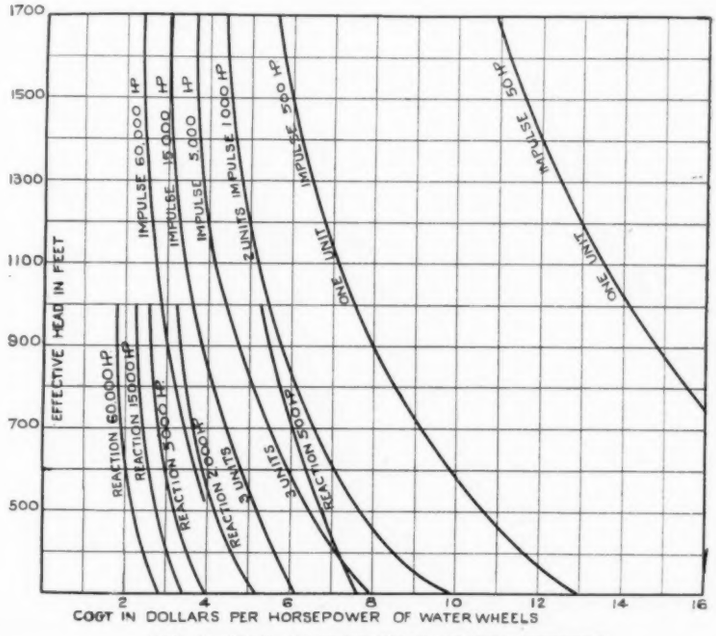


FIG. 4.—COST OF HIGH-HEAD WATER WHEELS.

velocity of water would be allowed, in the same way as in the case of the steam plant, turbine efficiency is sacrificed by using high-pressure steam on the low-pressure side. Taking as an example the Lowry plant in Table I, the added building cost for an increase of 100 per cent in turbine capacity would only be ing steel-encased turbines, the additional cost per horsepower is much less as the additional turbines, all complete with casings, will only cost four or five dollars per horsepower and the added floor space will not exceed twenty-five to fifty cents per horsepower.

It must further be understood that to maintain the power at the fixed speed. Frequently where the head is low, three times the normal power in turbines must be installed, thus adding twenty dollars in wheels and about six dollars in building, making a total cost of ninety-nine dollars for the Lowry plant.

The transmission cost, depending, as it does, on the distance, can only be allowed for when this distance is known. A wooden-pole line will cost from $600 to $2,000 per mile, exclusive of a private right of way. A steel-tower line on a fifty-foot private right of way will cost $5,000 to $6,000 per mile with land at $200 per acre and fenced in. The substation cost may be taken from curves A in Fig. 7. It will be seen that this cost runs from about $6 for very large plants up to $40 for small powers. Taking the 300-horsepower plant size, $22 must be added, making a total of $121 per horsepower, for a small plant seriously affected by back water. This cost is now higher than the largest steam plant but still below the cost of a small one.

As an example of the cost of operation, take the Charles City plant, Table I. The power-plant operation cost is $23.20; substation, $10.00; transmission (15 miles assumed), $8.00; making a total of $41.20. This is the total annual operating charge for twenty-four-hour power, every item being allowed for, except lands and water rights. This is on the assumption that the development is based on the minimum flow of the stream, and that the full load is sold 24 hours per day, 365 days per year.

The above cost will remain practically the same for ten-hour operation, the only item that is reduced being that of attendance. For ten-hour operation and a load-factor of 100 per cent, the cost would be, for a 300-horsepower plant, $32.40 per horsepower per year, and as the plant could only sell 3,650 horsepower-hours per horsepower of turbine, the cost will be $0.0089 per horsepower-hour delivered to the consumer.

As a matter of fact, a 100-per-cent load-factor is seldom attained, about 33 per cent being a fair average. This will necessitate installing three times as much (peak load) machinery, and this greatly increases the capital charge against the plant. In the preceding example 900 horsepower in water wheels must be provided for with the necessary increase in generators, if the same output is to be sold, or, for the same equipment, only about 100 average horsepower could be sold, giving for a ten-hour load, 1,200 horsepower-hours per year output for each horsepower installed, and making the cost per horsepower-hour, $0.0267. This latter cost is consistent with the working conditions of such small plants having unusually high first cost and fairly long transmission.

By use of the curves giving power-plant costs and allowing for lands, vested rights, transmission, canals, etc., a fairly exact estimate for any particular plant may be arrived at. Allowing 9 to 10 per cent for fixed charges and adding the operating charges as given by Figs. 6, 7 and 8, the total operating cost may be had. This cost will compare with the fuel-plant cost, but there may still be the cost of distribution, such as for city lighting, etc.

Or, a more hasty and approximate method is to take some of the operating costs given in Tables I and II and then allow for the additional items enumerated above.

TABLE II. COST OF DEVELOPMENT, TWENTY-FOUR HOUR POWER.

(Based on report of Ontario Hydro-electric Commission.)

Name of Power	Head	Net Horsepower at Turbine Shaft	Capital Cost per 24-hour Horsepower at Turbine Shaft	Operating Cost per net Horsepower at High-Tension Switchboard of power house
Iroquois, Ont.	12	1200	$149.16	$24.00
High Falls, Ont. A	78	2400	81.25	11.90
High Falls, Ont. B	78	1100	111.82	17.00
Fountain Falls, Ont.	27	2400	89.16	13.00
Dog Lake	347	13675	61.00	6.80
Cameron Rapids	39	16350	50.00	5.80
Slate Falls	32	3686	97.00	10.40
Healeys Falls	60	8000	84.38	10.20
Middle Falls	30	5200	91.37	11.00
Ranney's Falls	35	6000	69.67	
Rapids above Glen Miller	18	3200	109.38	
Rapids above Trenton	18	3200	115.63	
Niagara Falls	250	100000	86.00	9.32
Maitland River	80	1600	203.00	17.40
Saugeen River	40	1333	187.53	18.30
Beaver River	420	2267	128.28	
Severn River	52	4000	87.50	14.00
South River	40	750	153.33	21.20

In comparing a steam plant with this small hydroelectric plant, the steam plant is assumed to be located at the same spot as was the substation of the water power. It is therefore free from the transmission and substation costs.

It would seem that the cost of developing a horsepower by steam should be known within two or three per cent, yet we have the marked disagreement indicated in Table III.

TABLE III.

Cost of 10-hour power; coal at $3, 300 Horsepower.

Wm. O. Webber	$37.50
Ontario Commission	26.27
A. F. Nagle	43.57
Wm. E. Snow	25.00
Average	$34.08

These estimates do not include the administration charge allowed for above in the case of the hydroelectric plants, nor the replacement fund. Allowing for these items, six dollars must be added to the above, making the cost forty dollars per year. The fact that a water wheel as usually rated has little overload capacity while the steam engine has 25 to 100 per cent overload, complicates the comparisons at this point. The above costs of steam power, no doubt, cover a peak overload of about 50 per cent, and therefore give an operating cost much less than would actually be the case, and in the proportion of two to three, giving a cost per horsepower-hour for ten-hour power on the basis of horsepower rating of water wheels, of $26.66, which is considerably less than the cost of the water power. However, in order to get this 50-per-cent peak overload capacity in the case of the water power, the additional turbines, flumes and penstock necessary add but $3.24 to the annual operating cost, giving a total of $35.64. This is now on the same basis as the 300-horsepower steam plant and compares more favorably with its cost of $34.08. If the cost of the long penstock is eliminated, the water-power cost is $33.51, or less than that of the steam cost. The difference, however, is slight and far inside the accuracy of calculation as appears from the above tabulation of steam-power costs. The cost of water rights would be about $10 per horsepower, making an operating cost of 70 cents to be added to the above.

It would, therefore, appear that even in this case a small water power costing $100 per horsepower of turbine installed, stands on an equal footing with the steam plant using coal at $3.00 per ton. For each dollar that the coal costs less than $3.00, the operation of the steam plant will be reduced $3.20 per horsepower per year for ten-hour power.

This example illustrates several important points. It marks about the limit of wise investment and indicates that beyond this limit a steam or producer plant should be built, or that a less expensive development should be installed. It is apparent that the undeveloped water rights are not of great value in this case, and that such values are entirely dependent on the cost of development, the transmission distance and the cost of fuel, and are not, as has so often been assumed, a fixed sum all over the country. In other words, the undeveloped water rights with all necessary lands are worth the capital-

ized saving in the cost of production of the water power over the production of the same power by some imported plant, and when this saving becomes zero such property has no value at all.

It further shows that the usual small water power, while not a get-rich-quick investment, should, when properly developed, be a much better proposition than the steam plant. As a matter of fact, the Charles City plant did drive out a modern steam plant or at least drove it to such favorable terms that it soon became a part of the water-power system.

As the water power grows in size and the head becomes higher, the operating cost becomes less.

It is apparent that in practically all water powers, it becomes a question as to how much above the minimum flow of the stream it is wise to develop. The question of reservoirs, etc., also enters into the problem, but in every case the same rule applies, which is, that the additional power secured must not cost more than if developed from a fuel plant. It is the effort to develop to this point that has produced the costs given in Tables II and IV. That is, these tables indicate what has been considered as the economic limit of development and indicate this limit to be about $150 per horsepower. No doubt these plants have been, as a whole, financially successful, although a few have changed hands soon after building owing to a lack of capital to develop the market.

There can be no question but that when the cost of fuel is high, even $300 per horsepower would not be an excessive price to pay for a water right.

It is true that a water power may be so developed that it will cost unreasonable sums, but the same might be said of any investment. The mining of a pound of solid gold may cost more than it is worth, and it is absurd to base comparative figures on such freak developments. Take, for instance, the McCall Ferry development. A construction bridge of reinforced concrete, costing some $100,000 was built, when a steel structure would have served the purpose and its salvage been of some value. Thousands of yards of rock were needlessly excavated, and the useless cavities filled with costly concrete. A solid concrete dam was built which cost at least $250,000 more than a modern dam would have cost, etc. It is such developments that the steam-power advocates compare with steam costs.

It is in the operation of the water-power plant, however, that we find the greatest advantage over that of the fuel plant. Table V indicates the fixed charges for the two types of plant.

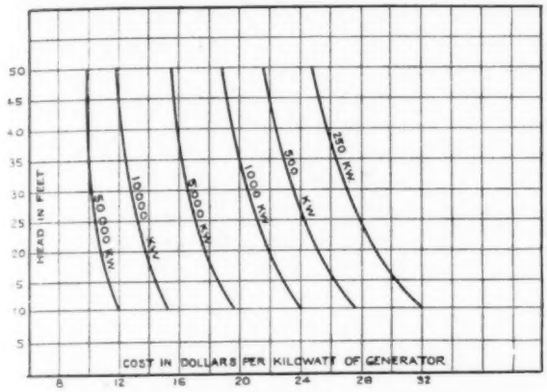


FIG. 5.—COST OF ELECTRICAL EQUIPMENT.

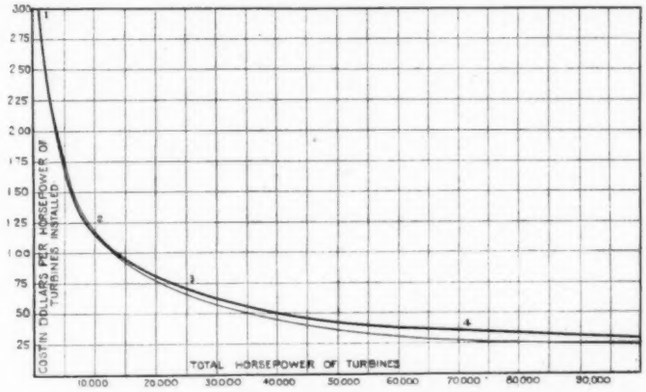


FIG. 6.—ANNUAL COST OF ATTENDANCE IN HYDROELECTRIC PLANTS.
Twenty-four-hour Operation. Ten Attendants.

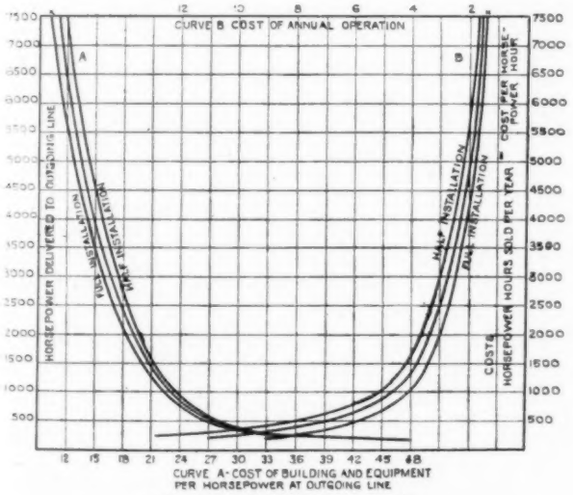

CURVE B COST OF ANNUAL OPERATION
HORSEPOWER DELIVERED TO OUTGOING LINE
HALF INSTALLATION
FULL INSTALLATION
COST PER HORSEPOWER HOURS SOLD PER YEAR
CURVE A-COST OF BUILDING AND EQUIPMENT PER HORSEPOWER AT OUTGOING LINE

FIG. 7.—SUBSTATION COSTS.
Sixty-cycle Three-phase Installations. No Allowance for Land, Replacement or Administration. Interest Charge Six Per Cent, Taxes Two Per Cent, Depreciation Seven Per Cent. Twenty-four-Hour Operation.

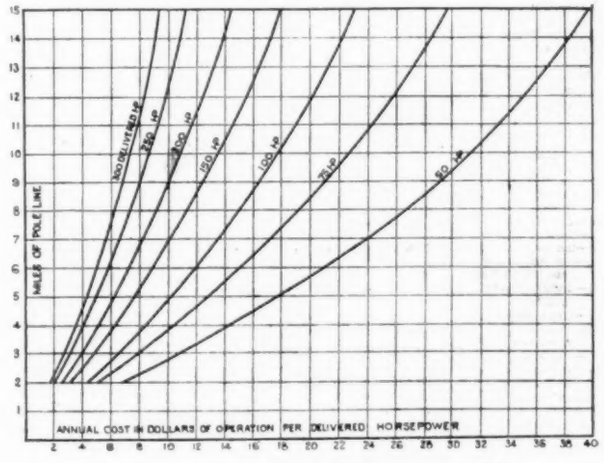


FIG. 8.—TRANSMISSION OPERATION COST.
No Allowance for Land or Buildings. Interest Charge Six Per Cent, Replacement Three Per Cent, Taxes One Per Cent, Maintenance Two Per Cent. Copper at Twenty Cents per Pound, Poles $7.50, Patrol $25 per Mile. Loss in Line and Transformers, Seven Per Cent.

The steam plant, being located in the city, will pay a higher tax rate than the water power in the country.

While the fixed charges on the steam plant will remain about the same for various plants, those on the water power will vary between wide limits, owing to the fact that the machinery cost for the latter is a comparatively small portion of the total, the remaining cost being in dams, canals, water rights, excavation and other items having a very low depreciation or obsolescence charge. Such parts should have a life of a hundred years if properly built. Judging from the experience of the Niagara Falls plant as given by Philip P. Barton, the maintenance on electrical equipment is less than 0.75 per cent; the obsolescence charge on the switching equipment is 5 per cent, and on other electrical equipment 1 per cent. Mr. Hutchinson gives a depreciation plus maintenance charge of 2 per cent on transmission lines of importance, but the writer uses 3 per cent to cover this item.

TABLE IV.

(From Meads *Water Power Engineering*)

Name of Location	Head in feet	Net horse-power at Turbine Shaft	Cost per horse-power of Turbines	See Note below
Chicago Drainage Canal	28	15,500	225.80	d
Columbus, Ga.	40	9,000	50.00	e and e
Catawba, S. C.	25	10,000	110.00	d and f
Tariffville, Conn.	31	2,300	125.00	d
Delta, Pa.	42	550	54.00	d and g
Lachine, Montreal	16	6,600	145.80	d and h
Winnepeg, Manitoba	40	25,600	156.25	d and i
Manchester, N. H.	30	6,000	66.00	a and j
Lowell, Mass.	15		110.00	a and j
Lowell, Mass.	18		57.00	a and j
Big Cottonwood, Utah	370	3,000	108.25	d and k
Lawrence, Mass.			67.50	a and j
Spier Falls, N. Y.	90		42.00	o
Zurich, Switzerland	very low	25,300	183.00	d and l
Rhinefelden, Germany.	10 to 16	15,000	81.70	o
Paderno, Italy.	90	13,000	120.00	b
Champ, France	104	6,750	148.00	d
Dept. de l'Isere, France	330	4,000	34.00	b
Dept. de Jura, France	6.5	300	150.00	d
Upper Savoy	450	11,000	165.00	c and m
Chedde, France	455	10,000	35.75	a,c and n
Chevres, Switzerland	14 to 27	9,000	109.00	b
Kubel, Switzerland	296	500	215.00	d and o
Schaffhausen, Germany.	11 to 16	2,700	135.00	d and p
Gersthofen, Germany.	32.8-34.8	6,000	135.00	b
Augsburg, Germany.		9,100	206.00	d
Heimbach, Germany	230to360	16,500	130.00	d and q
Lyon, France.	33 to 40	22,750	287.50	d and r
Muhlhausen, Germany	24 to 30	23,000	132.50	b
Munich, Germany	25 to 28	5,660	123.00	c and i

a—the cost of development exclusive of dam.
b—the cost of development including dam.
c—the cost of complete development including electric equipment.
d—the cost of complete development including electric equipment and transmission.
e—mostly 12-hour horse-power distributed to adjacent mills at generated voltage.
f—severe climatic and river conditions during construction.
g—very favorable location; cheap timber dam, transmission only 5 miles.
h—inclusive of lands.
i—expensive canals in rock and expensive concrete construction
j—factory installation.
k—Pelton wheels and 1500 feet of wood-stave pipe.
l—four interconnected plants and steam auxiliary.
m—not including 5000-horsepower steam auxiliary.
n—not including dam.
o—with 1000-horsepower auxiliary.
p—two connected plants.
q—15-mile transmission.
r—12-mile canal.

It should be noted that the greater the cost per unit of power plant, the lower will be the fixed charge; 2.5 per cent for the average plant should be a fair average. The fixed charges against the steam plant are about twice those against the hydroelectric and if the other operating expenses were the same for both plants, the water power may cost twice as much and still be on an equal footing with the steam plant. However, the variable charge, if it may be so called, is the one thing that has appealed to the lay mind, and no doubt caused the present excitement relative to hydroelectric plants. Aside from a very small charge of ten or fifteen cents per year for oil per horsepower, the only cost is the attendance. Fig. 6 gives values for this cost. It should be noted that the attendance item for a water power is much lower than for a fuel plant of the most modern type.

Hydroelectric plants have frequently cost excessive amounts, and the following are some of the reasons for this in addition to those already given. These are what might be called the illegitimate costs. The modern hydroelectric development is a novelty to the large majority of contractors, and they hesitate to bid at all, and when they do bid it is at about twice the actual cost. On one installation sixteen sets of specifications were sent out, and two bids received. One of these bids was 100 per cent above the estimated cost and the other within 10 per cent. Frequently the interests promoting such enterprises form a construction company, and make excessive profits. The promoters frequently get options on the lands and water rights and sell them to the company which they promote, at a high valuation. Again the contract is let on a cost-plus-a-fixed-sum basis, and, unless the contractor is perfectly honest, the cost is made unnecessarily high. Again the case is frequent where the cost of the dam is a large factor in the cost of the plant and a solid dam is built costing twice that of the buttressed dam, and having a factor of safety of one. The power houses are built of solid concrete when reinforced concrete is cheaper for the purpose.

The steam plant is only slightly affected by local conditions. Contractors bid close to the estimate, and the engineer knows, by well established precedent, about what is expected of him.

TABLE V. FIXED CHARGES IN PER CENT.

Item	Steam Plant	Water Power
Interest	6	6
Insurance	0.5	0
Taxes	2	1
Maintenance	5	1
Obsolescence	5	1.5
Total	18.5	9.5

Regarding the future relations between the water power and the fuel plant, the following may be said. Granting that the producer gas-engine plant is to become perfected and will use one-half or one-fourth the coal now used by the steam turbine to produce the same power, there is no reason to forecast that the cost of plant will not remain excessive. It is also quite possible that the price of coal will steadily increase. It would be very strange, indeed, were this not the case, as it would be the only article of household and general use that is not rapidly increasing in cost, at the same time being about the only commodity that must soon become exhausted. The coal veins are becoming more inaccessible, and the law will sooner or later compel safer mining. Labor, especially manual, is sure to double in price about every twenty years. Government control will add cost to the mining operations and especially if large combinations of capital are prevented. The only thing tending toward a decrease in cost of fuel power is in the cheapening of the producer and gas engine, and it would seem too optimistic to hope for a less cost per horsepower than $100 for the gas-engine plant.

The gas engine has little overload capacity, and hence, to give it its overload rating of 100 per cent, as was done for the steam turbine, the cost per horsepower becomes $175. One authority gives a cost of $150 per horsepower for a gas-engine producer plant having a 33-per-cent overload capacity. The rate of fixed charges on this investment will certainly exceed that for the steam plant, as the item of obsolescence will be greater. Another inherent disadvantage in the gas engine is its very low efficiency on low load-factors. In actual practice, therefore, this plant would have to contain a certain proportion of steam turbines, thus increasing the operating cost.

Even should the item of fuel be entirely eliminated, still this gas plant would have over twice the operating charges (assuming a fixed charge of 19 per cent) necessary with the average hydroelectric development. That is, the latter could cost $350 to install and still compete, even though the coal used by the gas plant were zero. Gas engines of more than 5,000-kilowatt ca-

pacity each are considered curiosities (note the seventeen 2,500-horsepower engines at Gary, Ind.), and it is probable that this size will not be greatly increased. Therefore, a large plant would consist of a great many units requiring the attention of numerous operatives far in excess of those required by the water wheels. In addition are the producer attendants. Therefore, it is only to the cheapening of the plant that we must look for the cheapening of power, and it does not seem reasonable to expect such reduction in cost to greatly exceed the cheapening of hydraulic equipment. The water turbine is being perfected so that where 80 per cent was thought to be satisfactory a year ago, 90 per cent can now be attained. The part-load efficiency of water wheels is so rapidly increasing that now the engineer is justified in assuming the average operation at three-fourths gate, thus giving the wheels 33-per-cent overload capacity, or even better. Contractors will soon be willing to figure more closely and do the work at less cost. The price of concrete materials is steadily diminishing and the cost of placing is about half what it was a few years ago. The cost of excavating is steadily being reduced. Manufacturers are rapidly taking up the manufacture of hydraulic specialties, as will become apparent on an inspection of the advertisements in the engineering journals. Transmission towers are becoming cheaper and higher voltage used, etc. And, in fact, the future has nothing but omens favorable to the cheapening of first cost and the betterment of the water power as an investment.

Much can be said on the question of which type of power plant gives the best results on low load-factors. Much depends on the understanding or use of the term, load-factor, but assuming it to mean the total kilowatt-hours sold per annum, divided by the kilowatt-hours which can be economically produced, it will appear that the plant having the largest fixed charges will give the largest unit-output cost on a low load-factor. The extent of this difference will, however, be largely affected by the load distribution over the period, and frequently, even though the cost of production is increased, the market conditions may be such that a low load-factor actually gives increased profits, owing to the higher charges imposed on the customer. Two rival plants entering upon the conquest of market are not compelled to sell to the same customer, but each attempts a selection of customers best suited to its particular plant. In practically all power and lighting or railway load curves, there are abnormal peaks caused by special days. Any power plant must have installed sufficient machinery to carry these "special-day" loads, and it becomes merely a question of which type of power plant entails the largest charge on this extra machinery. Now, logically, the charges on the water-power peak-load machinery can never *exceed* that of the fuel plant, because if it does, fuel plant will be installed instead of water wheels. Of course, if the water plant necessary for the *average* load has greater operating charges, then the water power must be left undeveloped or developed more cheaply.

The writer claims that the average water power is especially adapted to fluctuating loads and to take care of low annual load-factors. How can this be otherwise when additional turbines cost but a half to a tenth of what a steam turbine costs and all other costs are at least as low in one case as the other? There are, of course, cases where excessive penstocks, canals or tunnels, and lack of reservoirs, places the water power at a disadvantage.

It may, at first thought, seem that there is a disadvantage in operating a mixed plant, but there is no good reason why this should be so. If the transmission is a long one, a steam-turbine plant is installed near the market, and the high-speed turbine with its great flywheel effects acts as a regulator, automatically and perfectly, and without in any way complicating the administration of the plant. If the auxiliary is located at the water power, it is usually held as a stand-by plant for the special days or for the period of low water, and when operated is given a steady load, the water plant taking the peaks. In this case the outside men are called in to fire the boilers, and the engineer of the water-power plant operates the combination. At all events, the selection of peak-load machinery is not regulated by any other law than that of business sense, and such judgment will not install a plant which has a higher operating cost than is thought to be at least as low as that of any competitor.

The question uppermost in the minds of the people, however, is not that of which type of power plant is the best investment, but how shall the coal fields and the waterfalls be conserved. There are also many who question the advisability of such control. Were all humans divine, control would not be advisable, but under operating conditions it would seem that there should be State or Government administration which oversees each development and imposes a certain charge, for which the Government in return gives improved drainage areas, etc. Taking it for granted that the engineers appointed by the Government are honest and wise, such direction would determine the extent of the development, and see to it that safe and efficient structures were built.

There are today few water powers of value which are not owned by private capital and, to the writer, it seems futile to attempt to prevent the securing and combining of these rights by large capitalists. In fact, it is only by a combination of numerous small powers that effective development may be affected on such rivers as the Kankakee in Illinois, the Cuyahoga in Ohio, the Oriskany in New York, and many others.

All that may be hoped for, and all that should be desired, is the regulation of the price charged by these corporations and the regulation of the distribution.

Has not the community, possessing within its borders a large water power, certain rights which are transgressed when all that power is transmitted a hundred miles or so away? This and similar questions are legitimate problems for solution by the Government.

The water power should in all cases be a first-class investment, and when developed wisely will often necessarily cost more per unit installed than does the fuel plant, simply because the operating cost is so much less that it will stand such development, but if underdevelopment is followed the plant cost will be much less than for any other form of power.

The St. Louis Section Meeting.

At the December meeting of the St. Louis Section, American Institute of Electrical Engineers, on December 21, Prof. Francis E. Nipher, of Washington University, will make an address.

Annual Meeting of the American Society of Mechanical Engineers.

One of the most successful annual meetings ever held by the American Society of Mechanical Engineers was called to order in the Engineering Societies Building in New York on Tuesday evening, December 6, with President George Westinghouse in the chair. The large auditorium was filled to its capacity by members and guests to listen to Mr. Westinghouse's presidential address. It is the custom for presidents of this society to discuss some phase of engineering work in which they have made a notable success. Mr. Westinghouse chose for his topic the Westinghouse air brake, for the development of which he is almost entirely responsible.

Mr. Westinghouse related how the idea of a brake which could be applied simultaneously to all cars of a train occurred to him as the result of a collision which delayed a train on which he was a passenger. His first idea of a brake, which he later found had been held by others, was to connect the brake levers of each car to its draft gear so that the application of brakes to the engine would cause the cars to close up on each other toward the locomotive and thereby apply a braking force through the couplers and brake levers to the wheels. This scheme proving impracticable, Mr. Westinghouse considered placing a steam cylinder on the locomotive, whose piston was to be connected to a chain extending underneath the train and connected to the braking mechanism of each car. It soon developed that this plan was not feasible since it was impossible to have a cylinder long enough to operate a chain on more than four or five cars, whereas trains of ten or twelve cars were in common use. The next development was the idea of placing a steam cylinder under each car with a flexible pipe connection to the locomotive to supply the brake cylinders with steam. Experiments soon showed, however, that it was impracticable even in warm weather to transmit steam to the rear cars of even a short train in sufficient quantities to operate the brakes.

Mr. Westinghouse then told how the idea of using compressed air as his braking force was brought home to him by a description in a technical journal of the method of driving the Mount Cenis tunnel with compressed air, and how with co-operation of the superintendent of the Panhandle railroad the first air-brake equipment was constructed and applied to the Steubenville accommodation train consisting of a locomotive and four cars. On the first run of this train so equipped, a serious accident was averted by the ability of the train to make a quick stop by the application of the air brake, which demonstrated its value and started it on its useful and successful career.

Following the successful application of the apparatus on the first train the introduction of the air brake proceeded rapidly, and the Westinghouse Air Brake Company was formed to manufacture it. It soon developed that it took considerable time to apply the brakes with full force and a longer time to release them, and that in the event of a break-in-two of a train, the rear sections would be uncontrolled and on a gradient might run away with disastrous results. This led to the development of the automatic brake which was identical with the original air brake but with two important features added. These were an auxiliary reservoir under each car and also a triple valve. Air for operating the brake cylinder was taken from the auxiliary reservoir while the function of the triple valve was to release the brake by opening a passage from the brake cylinder to the atmosphere and also to provide a passage from the train line pipe to the auxiliary reservoir whenever air under pressure was admitted to the train line pipe from the main reservoir on the engine. This was the normal condition of the system. When the pressure in the train pipe was decreased by the engineer opening his control valve, the triple valve then closed the communication between the brake cylinder and atmosphere and established communication between the auxiliary reservoir and the brake cylinder, thus applying the brakes. Any escape of air from the train pipe by its rupture or by the breaking in two of the train immediately applied the brakes on all the cars.

Mr. Westinghouse then described the work with an experimental train of fifty freight cars, now known as the Burlington brake trials, which proved the inadequacy of the automatic brake due to its slowness of operation on the rear cars of a long train, and the development of the present quick acting brake. This was accomplished by means of changes in the triple valve which rendered the application of the brake practically instantaneous on every car of a long train. Mr. Westinghouse also described the present status of the air brake and paid a glowing tribute to the officials of the railroad companies for the co-operation which they had given in the development of this most important adjunct of modern railroading.

The report of the tellers of election was presented following Mr. Westinghouse's address. The present election was unique in that there was a contest for the presidency. The vote was very close and the count showed that Colonel E. D. Meier, president of the Heine Safety Boiler Company had been elected president of the society.

The serious work of the meeting began on Wednesday morning. After the transaction of routine business, including the adoption of an amendment to the constitution, a report of the recent joint meeting held in England with the Institution of Mechanical Engineers was delivered by the secretary, Calvin W. Rice. He recounted the numerous enjoyable social and engineering features of this meeting.

TRANSMISSION OF HEAT IN CONDENSERS.

The only paper to be presented Wednesday morning was entitled, "The Transmission of Heat in Surface Condensation."

The paper, written by George A. Orrok, contains the results of 771 heat transmission tests made by the author on sixteen kinds of condenser tubes under various conditions of condenser practice. It also includes eighty-four tests made by Allen in England, forty-seven tests by Hepburn in the United States, fifty-three tests by Hagemann in England, forty tests by J. P. Joule, forty-one tests by Stott and Pigott, forty tests by Weighton, thirty-five tests by Josse and thirty-four tests by Clement and Garland. These tests have all been calculated on the same basis and compared, and the author concludes from the tests that the heat transferred from the condensing steam surrounding a metallic tube to cold water flowing through the tube is proportional to the seven-eighths power of the mean temperature difference of the water and steam; he finds that the coefficient of heat transmission is approximately proportional to the square root of velocity of the cooling water and this coefficient is independent of the vacuum and of the velocity of the steam among the tubes or in the condenser passages.

STEAM BOILER EFFICIENCY.

The session of Wednesday afternoon was devoted entirely to steam engineering. Edward A. Uehling presented a paper entitled "Combustion and Boiler Efficiency."

This paper stated that the efficiency of the steam generator depends on conditions far more complex than does that of the steam engine or electric generator. The latter, when properly designed, constructed and adjusted to their work will operate at maximum economy and the attendant can do little to change their efficiency. With a steam boiler no adjustment is possible and reliance must be placed on proper attendance. Many modifying factors such as atmospheric conditions, quality of the fuel, both chemical and physical, rate of driving, etc., enter into boiler operations and render fixed adjustment impossible. The heat carried off by flue gas in general boiler-room practice seldom is as low as fifteen per cent and often is forty per cent of the calorific value of the fuel.

In the discussion of this paper one speaker objected that there was no practical carbon-dioxide recorder for continuous operation. Another speaker contended that the efficiency of combustion is the most vital subject in power-plant operations today, that beside it the efficiency of the steam turbine is a mere detail. The question of efficient boiler operation is largely one of air leakage and a test was cited where the percentage of carbon dioxide in the flue gases had been increased from four to eleven by merely plugging up all leaks in the boiler setting and thus stopping infiltration of air. The determination of carbon dioxide in the flue gas does not fulfill all the requirements for good boiler economy. A low carbon-dioxide record indicates that something is wrong in the boiler plant but it does not show what is wrong. The only safe method is to take continuous records also of oxygen and carbon monoxide. It was recommended that a bonus should be paid to the fireman for continuous high carbon-dioxide records. Professor William Kent stated that he had used an autographic register of furnace temperatures as long as fifteen years ago and that in his experience he had found that the best index of boiler efficiency was a continuous pyrometer record of the furnace temperature. A high furnace temperature indicated invariably a high boiler efficiency. The most important factor he stated in obtaining good boiler economy was the use of dry coal. Professor D. S. Jacobus stated that there was as much loss in boiler economy from running the boilers much below rating as there was from excess air. In power-plant practice, especially, it is better to shut down boilers between peaks of the load and run the remaining boilers at high rates of driving than to keep a large number of boilers at work with slow fires.

CONTROL OF CONDENSING WATER.

B. Viola then presented a paper on the automatic control of condensing water with special reference to barometric counter-current condensers in connection with vacuum pans.

The author described the construction of the condensers and showed a system whereby the cooling water is handled economically by means of an automatic controlling device which was illustrated in the paper, together with recording charts from it. The paper was severely criticised in discussion, one speaker especially condemning it because there were no records given from which an engineer could draw conclusions either as to its economy of operation or its automaticity of action. It was also questioned whether this apparatus would give good results when used in connection with a steam turbine. The steam turbine in central-station practice was subjected to considerable load fluctuation and if the apparatus described in the paper would not respond to fluctuations rapidly, which the speaker doubted, it would prove of little service in connection with turbine work and might be detrimental rather than otherwise.

The next two papers being of similar character they were read together and discussed at the same time. The first was entitled "Tests of a 9,000-kilowatt Turbo-Generator Set," and was written by F. H. Varney, San Francisco. The second paper, "Test of a 10,000-kilowatt Steam Turbine," by Sam L. Naphtaly gave the results on a turbo-generator unit at the plant of the City Electric Company, San Francisco, the tests being made under operating loads, and their object being to determine the general steam consumption of the unit under every-day operating conditions, and further to determine the fulfillment of the builder's guarantees.

EFFICIENCY TESTS OF TURBO-GENERATOR UNITS.

The steam pressure was to be 175 pounds gauge, superheated 100 degrees Fahrenheit and the vacuum to be twenty-eight inches, measured in the exhaust pipe and referred to a thirty-inch barometer. The normal operating speed was to be 1,800 revolutions per minute. The generator was designed to deliver sixty-cycle, three-phase current at 11,000 volts, the voltage being maintained constant at all loads by means of a Tirrill regulator. At this voltage the generator was to deliver 525 amperes per terminal. It was of the inclosed type and provided with a direct-connected exciter driven from the end of the main generator shaft.

The turbine described by Mr. Varney was rated at 9,000 kilovolt-amperes, or at an eighty-per-cent power factor it had a capacity of 7,200 kilowatts. The guaranteed efficiency at the full load of 9,000 kilowatts with unity power-factor, with steam at 175 pounds gauge pressure, with superheat of 125 degrees Fahrenheit, and a vacuum of not more than two inches absolute back pressure in the exhaust chamber, was the generation of a kilowatt with 16.4 pounds of steam. The machine was tested on the regular commercial load which was kept as nearly constant as possible. The duration of the test was about four hours with an approximate load of 7,000 kilowatts and this was followed immediately by another run of four hours with an approximate load of 9,000 kilowatts. The final result of the test for the 7,000-kilowatt load was 16.06 pounds of steam per kilowatt-hour without correction, or 15.82 pounds of steam with all corrections made. Under the 9,000-kilowatt load the uncorrected steam consumption was 15.95 pounds and the corrected consumption 15.42 pounds which at the lower load was approximately three and one-half per cent above the guarantee and at the higher load approximately six per cent better. The complete apparatus tested comprised a vertical Curtis turbo-generator, Worthington condenser and vacuum pump and eight 750-horsepower McNaull water-tube boilers. The plant is oil-burning and the boilers are equipped with superheaters for 100 degrees superheat.

In the discussion of Mr. Varney's paper it was pointed out that while the actual performance was within the guaranteed water rate this was not especially creditable to a 9,000-kilowatt machine. While the vacuum during the test was not especially good, with injection water of from fifty-one to fifty-two degrees Fahrenheit, it should be possible to reduce the absolute back pressure about one inch, which would materially improve the water rate of the turbine. A superheat of seventy-five degrees at maximum load is also rather low for the best results and a superheat of 150 degrees would probably have increased the economy of the machine by about six per cent. Referring to Mr. Naphtaly's paper, the same speaker said that inasmuch as the temperature rise of the 10,000-kilowatt generator was only sixty degrees after a twenty-four-hour run at fifty-per-cent overload the machine might well be rated as a 15,000-kilowatt machine.

E. D. Dreyfus stated that doubling the rotative speed of the turbine reduces the steam consumption from four to six per cent depending on the size. In 1,000-kilowatt turbines of 3,600 and 1,800 revolutions per minute respectively tested by the United States Government a difference of 4.5 per cent was shown. Mr. Dreyfus showed curves giving the relations between economy and superheat. It is believed that the efficiency ratio consistently improves with increasing superheat up to 100 degrees Fahrenheit when a further delay of the occurrence of the saturation point is offset by the greater heat in a pound of steam passing out through the exhaust. Likewise, at the other end of the scale there is a point where improvement in turbine operation is counterbalanced by the increased power demanded by the auxiliaries. In

these latitudes the most economical vacuum is between twenty-eight and twenty-eight and one-half inches referred to a thirty-inch barometer. Mr. Dreyfus presented a temperature-entropy diagram by which he showed that the increase of vacuum from twenty-eight to twenty-nine inches made an amount of heat available for work in the turbine equivalent to that obtained in raising the steam pressure from 190 to 305 pounds absolute.

FLOW OF STEAM THROUGH AN ORIFICE.

The final paper of this session was presented by Isaac Harter, Jr., and gave some notes on the value of Napier's coefficient for the flow of steam through an orifice when used in connection with superheated steam.

The paper comprised a report of a series of determinations of the value of this coefficient for steam at pressure averaging 160 pounds per square inch absolute, and for various degrees of superheat ranging approximately between fifty and 200 degrees. The results of the test were plotted in three curves and show a numerical increase in the value of the coefficient corresponding with increased superheat; increase in volume flowing at constant pressure as the superheat increases; a decrease in the weight of steam flowing at constant pressure as the superheat increases.

BELT DRIVING.

At the Thursday morning session Selby Harr of the General Electric Company presented a new theory of belt driving.

Some of the most noteworthy features of the theory are: the maximum allowable tension increases with the speed; the coefficient of friction increases with the speed and reaches values far above that usually assumed; the maximum efficiency of transmission is not limited by the speed; as the speed increases the centrifugal tension replaces the initial tension so that the bearing pressure decreases, the speed of the belt is constantly changing, the regular cycle being repeated continuously when the load is steady. This assumption introduces a new treatment of the problem of belt creep. The author gave a method of calculating the efficiency of a belt and worked out an illustrative example.

The paper was criticized by several speakers including Carl Barth, Harrington Emerson, Fred W. Taylor and Professor William Kent, who pointed out that the values worked out by the theory were far outside the bounds of safe working conditions.

PASSENGER ELEVATOR PROBLEMS.

A most interesting paper was that presented by Reginald Pelham Bolton entitled "Operating Conditions of Passenger Elevators."

He compared the service of an elevator equipment in a large office building to that of a subway or electric railway line, stating that the conditions of traffic were quite similar and that peak loads had to be handled in the same manner as by other transportation agents and that equipment had to be maintained to handle these peak loads although it was idle or worked at low efficiency for the greater portion of the time. He directed attention to the effect on elevator work and economy, of the passenger movement and traffic by reducing the period of actual motion and by increasing the time occupied in the period of starting and stopping. The functions of acceleration and retardation were shown to be more important features than high running speeds and the superior capacity in this respect of the traction electric elevator were indicated. The effects of counterbalance were discussed in their relation to passenger traffic in order that the proper proportion of counterbalance should be determined by observations of the traffic. Diagrammatic records of such observations were thrown on the screen showing the effect of excessive traffic on the traveling powers of an elevator. Records from typical office buildings in different cities showed clearly how the habits of people in different sections of the country affected the elevator service. Results of an undue proportion of stops and starts were shown by records of tests which were plotted to correspond with the equivalent live load, and indicated excessive cost in power consumption.

The final paper of the morning was prepared by M. B. Kaven and J. B. Hadaway and described the operations of modern shoe manufacture. A description was given of a factory provided with all modern improvements for health, comfort and safety of employees, equipped with the latest type of shoe machinery, and of the principal operations in the making of the shoe.

The work on Thursday afternoon was divided between two sections, one relating to machine-shop work and the other to the gas-power section of the society. The machine-shop section was devoted entirely to three papers on grinding, entitled respectively "The Field for Grinding," by Charles H. Norton, "Precision Grinding," by W. A. Viall, and "Modern Grinding Methods." Mr. Norton's paper discussed the act of grinding as a cutting rather than an abrading operation and showed wherein the grinding machine had replaced the lathe in certain phases of machine-shop work. He described and illustrated actual operations in automobile work in which grinding methods had been used. Mr. Viall's paper discussed the size and limits of work which was to be ground. He also discussed the question of the amount of metal that should be left by the lathe to be ground off and presented a table in which the allowance varies from 0.008 inch to 0.012 inch diameter, which is sufficient to produce finished product free from all tool marks and yet allows the lathe department to supply the pieces at a minimum cost.

The gas-power section after hearing the report of the chairman, J. R. Bibbins, which recounted the work done during the past year and discussed the possibilities for future work of the section, listened to the reading in abstract of a paper by E. P. Coleman entitled "The First Large Gas-Engine Installation in American Steel Works." This is the plant of the Lackawanna Steel Company at Buffalo, New York, and being designed during the formative period of the gas engine does not represent the present practice. The operation is successful when considered from the viewpoint of continuity and reliability of service.

In the discussion of this paper Joseph D. Morgan of the Cambria Steel Company said that in many cases gas engine installation can be carried too far. No steel works in a region of cheap coal can use a gas engine economically although there were now but few steel works that filled this qualification. The power factor of a working plant by which Mr. Morgan evidently meant the ratio of actual output to the twenty-four hour maximum possible output, seldom exceeds fifty per cent when idle days, shut downs, etc., are deducted.

Another speaker discussed the dust problem in relation to the plant at Lackawanna. The dust content allowed in the gases at this plant would not be tolerated for a moment in a more modern plant. At the present time a dust content of fifty milligrams per cubic meter is considered prohibitive and twenty milligrams was considered very bad practice. A number of changes in gas engine design were suggested by this and other speakers, all with a view to making the service more reliable.

Following the discussion of Mr. Coleman's paper a paper by Nisbet Latta entitled "Notes on a Heavy-Duty Gas Producer" was presented. The recent development of the heavy-duty gas engine has not been duplicated by producer designers and no producer has been developed of the proper size and type to accompany these large units. The author outlined recent experiments on a producer designed to use pulverized coal and air in the proportion required to burn carbon to carbon monoxide. The tests are not yet conclusive but tend to show great possibilities for a heavy-duty gas producer of this type. Professor R. H. Fernald, of Cleveland, Ohio, was then conducted to the chair and adjourned the meeting.

CENTRAL-STATION PRACTICE

Transmission—Interior Wiring.

ELEMENTS OF POWER-STATION DESIGN—XVI.

OVERHEAD TRANSMISSION AND LINE CALCULATION.

BY W. B. GUMP.

The transmission line is readily conceded to be the weakest portion of an electric power system. This is due more to the lack of practical means for insuring continuous and efficient service, than to the limited knowledge of transmission line phenomena. The subject of transmission is such a broad one that the treatment here can give only the rudimentary data upon which the design of overhead transmission lines is based. It is to be understood, however, that the present treatment is sufficiently comprehensive to cover the preliminary computations relating to long-distance lines. Low-tension transmission will not be considered here, since calculations pertaining thereto are in most cases so simple that the data at hand conforms to the usual case without the introduction of more or less complex factors which are involved in the high-tension line.

It is not difficult to determine the character of a line having a definite and constant load, basing all calculations on a true sine wave. If a three-phase line (which is usual) is considered the preliminaries neglect all unbalancing and abnormal conditions. The difficulties encountered in attempting to arrive at accurate results are due to the fact that the assumptions upon which the calculations are based are at best only approximate, even under normal working conditions. Working values, however, can be very closely approached when the assumptions are carefully chosen and based on probable conditions.

Corona Effect.—Before taking up the calculation, a few brief statements are in order relative to electrical phenomena which impose limitations upon the potential employed, and hence upon the distance to which power may be transmitted.

One of the most fruitful sources of loss with high voltage is due to what is commonly termed the "corona effect." Electrical conductors at high potential become highly charged, to the extent that an actual flow of energy takes place between the conductors. This flow of energy shows itself in the form of a luminous "corona" which envelopes the conductor. At night the appearance is more marked, and presents little less than an awe-inspiring spectacle.

By means of a large number of observations and tests, the following conclusions have been reached regarding the corona effect:

(1) The loss due to corona effect takes place at a definite voltage which may be termed a critical voltage for the line in question.

(2) The critical voltage depends upon the conditions of the atmosphere, as well as the size and spacing of conductors.

(3) The critical voltage increases with the size of the conductor and the distance between conductors.

(4) The losses increase rapidly with increase in voltage, beyond the critical voltage.

(5) The losses due to corona effect are dependent to a large extent upon wave shape, and are greater with a peaked than a sine or flat-top wave. This is an economic consideration in the design of a long transmission line, and should be carefully investigated in its relation to the particular line involved.

Having looked into the electrical side as affecting the practical working of transmission lines, we shall now proceed to observe the commercial end of the problem.

The items ordinarily to be determined with reference to a transmission line are:

(a) Voltage.

(b) Frequency.

(c) Most economical metal for conductors.

(d) Best spacing of conductors.

(e) Effects of self induction, capacity, etc.

(f) Most economical span.

(g) Total investment in line, including interest, depreciation, etc.

Since every case deals with pecular local conditions, which are many and variable, it is clear that no rigid rules can be given. The only means of accurately determining the items above noted is by a number of trial computations.

In regard to item (a) practice has established an approximate scale of voltages for lines up to 100 miles in length, as follows:

Length in Miles.	Line Voltage.
1 to 2	1,000 to 2,300
2 to 3	2,300 to 6,600
3 to 10	6,600 to 13,000
10 to 15	13,000 to 22,000
15 to 20	22,000 to 44,000
20 to 40	44,000 to 66,000
40 to 60	66,000 to 88,000
60 to 100	88,000 to 110,000

From the above table we see that the voltage per mile ranges between 1,000 and 2,200 volts. As the distance of transmission increases, the voltage per mile decreases, due to electrical difficulties, as well as excessive cost of construction.

Suppose a transmission line is proposed, having the following data given:

Three-phase transmission; power to be transmitted, 10,000 kilowatts; distance of transmission, 70 miles; energy at receiving end used for lighting and railway power; power factor of load, 0.85.

It may be observed at once that less than 66,000 volts is uneconomical, and 80,000 volts is better than the first figure. We shall therefore base the preliminaries on a potential at the receiving end of 80,000 volts.

(b) The question of frequency is the next item, and this is often a troublesome question to settle. The trend of present practice is toward low frequency, where the main load is power. A frequency of sixty cycles per second is as high as practical conditions per-

mit, and the choice should be as much below this figure as is justified by the investment and the operating efficiency of the system. A frequency of twenty-five cycles for power alone is considered standard. For mixed loads forty cycles has been used to a considerable extent. On the Pacific Coast a frequency of fifty cycles is rather common. It is necessary to adhere to some standard frequency, on account of avoiding the inconvenience and extra cost of specially designed apparatus.

If the system under consideration involves, say, seventy-five per cent power load, and only twenty-five per cent lighting it may pay to adopt twenty-five cycles and employ frequency changers at the substation. We shall assume that in the present case the load is mostly power. A frequency of twenty-five cycles will therefore be chosen.

(c) The next question is whether to use copper or aluminum conductors. This matter resolves itself practically into a matter of cost, the procedure being to consider both and choose the cheaper.

The weight of aluminum for equal conductivity with copper is forty-seven

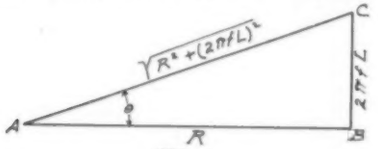


FIG. 1.

per cent the weight of copper. The more important properties of aluminum and copper are compared in the following table:

	Commercial Aluminum .99 pure	Copper
Per cent conductivity	62	100
Ultimate tensile strength in pounds per square inch	26,000	55,000
Ohms per mil-mile at 20° C.	88,200	56,700
Pounds per mil-mile	.00481	.016
Pounds per mil-ohm at 20° C.	424	830
Ohms per mil-foot at 20° C.	16.9	10.57
Temperature coef. per deg. C.	.004	.0042
Temp. coef. per deg. F.	.002	.00233
Specific gravity	2.68	8.9

Aluminum of sixty-two per cent conductivity purchased at 2.1 times the price of copper per pound will give the same length and conductivity for the same investment.

With either conductor (copper or aluminum) the cross section must be settled first. This cannot be arrived at until the current is determined, and since the line drop must be taken into account, it is necessary to assume a fixed line loss before commencing calculations.

Assume first a loss of eight per cent of the generated load. The power delivered at the receiving end is therefore

$$10{,}000-[10{,}000\times.08]$$
$$=9{,}200 \text{ kilowatts.}$$

The kilovolt-amperes at receiving end

$$K.\ V.\ A.=9{,}200\div.85=10{,}080.$$

Received current is therefore

$$I=\frac{10{,}080{,}000}{\sqrt{3}\times 80{,}000}=78 \text{ amperes.}$$

If we adopt a No. 000 stranded copper conductor the ohmic resistance is resistance per mil-mile multiplied by the distance of transmission divided by the cross-section in circular mils, or

$$R=56{,}700\times 70\div 167{,}800=23.6 \text{ ohms.}$$

From the foregoing we see that the price of aluminum per pound may reach twice the price of copper for the same total cost of the conductors, and still be feasible. If we base the cost of copper on seventeen cents per pound the cost of the line already assumed is computed as follows:

Weight$=3d\times$lbs. per mil-mile$\times$cross section.

$$210\times.016\times167{,}800$$
$$=565{,}000 \text{ lbs. (approx.)}$$

Therefore

$$\text{Cost}=565{,}000\times\$.17=\$96{,}000.$$

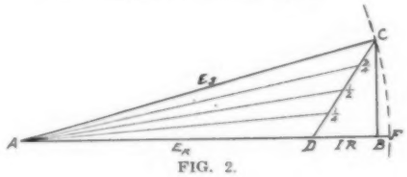


FIG. 2.

Aluminum at a price greater than thirty five cents per pound would therefore prove uneconomical.

(d) The spacing of conductors depends first of all upon the matter of safety. That is, the conductors should be as close to each other as safety will permit. Increasing their distance increases self induction. It also increases the cost of towers. The capacity decreases as the distance between wires is increased, but only to a small extent.

The arrangement for three-phase transmission is generally that of an equilateral triangle, in which case the line is balanced without transposition. When arranged horizontally it is necessary to transpose the lines, to decrease the self induction.

Volts.	Distance between wires in inches.
5,000	28
15,000	40
30,000	48
45,000	60
60,000	72
75,000	84
90,000	96
110,000	108 to 120

The spacing which is consistent with the best practice is given in the preceding table.

(e) The formulas involved in calculating self induction and capacity are derived by the methods of calculus, and are dealt with further on. An outline of the theory in elementary form is believed to be justified, on account of its important relation with all transmission line calculations since without a clear conception of the formulas employed these calculations can not be intelligently followed.

Consider first an elementary triangle as in Fig. 1, which depicts graphically the mathematical relation between ohmic resistance, reactance, and impedance. The base line AB represents, in direction and magnitude, the electromotive force required to overcome the resistance of the circuit. Likewise BC and AC represent reactance electromotive force and impedance electromotive force, respectively.

While this triangle indicates vectorially the magnitude of the electromotive force required to overcome the total impedance, there is no means of ascertaining the qualities belonging to the

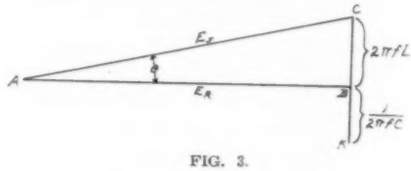


FIG. 3.

line itself, such, for example, as the line drop, reactance, etc. In order to separate these values the vector diagram in Fig. 2 is drawn. In constructing this diagram the following method, which was devised originally by Dr. Perrine and F. G. Baum, is applied. Draw first the horizontal line AD to any convenient scale, representing the voltage at the receiving end which is in phase with the current and overcomes the ohmic resistance. The ohmic drop in the line itself is shown by extending AD to B. It is equal to IR, as indicated. Erect a perpendicular from B to the point C. BC representing the reactance drop, and then connect A and C. The line AC, denoted by E_J is the electromotive force required at the generator terminals to overcome the ohmic resistance and the reactance of the line. The effect of capacity at present is neglected. The line connecting C and D is the vector sum of the reactance electromotive force and ohmic resistance drop of the

line, and represents the electromotive force required to maintain the received power current. For the line under consideration AD=80,000 volts, which is assumed to be full load voltage at the receiving end, seventy miles distant from the generator. This diagram assumes that the load at the receiving end is non-inductive.

Using AC as a radius draw the arc CF. It is now clear that between no load and full load the impressed electromotive force varies from AD to AF, rising to the latter voltage at no load when the IR drop in the line is practically nil. Likewise the inductive drop, since it varies with the current flowing in the line. The voltages for various loads respectively may be represented A_1, A_2 and A_3. Since this diagram accounts only for the effects of the line itself and does not take into consideration the influence of the load it is necessary to proceed further.

Observing next Fig. 3, it is clear that with the proper amount of capacity the self induction may be balanced, and the

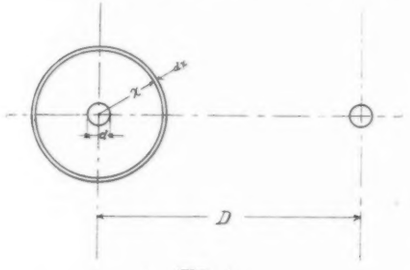


FIG. 4.

impressed electromotive force required will be only that necessary to overcome the ohmic resistance. Unfortunately, however, this condition cannot be maintained in the practical working of a line, for the reason that the self induction and capacity do not vary at the same rate, and when balanced for full load, are unbalanced for no load, or light load, and vice versa. The procedure generally followed is to obtain a balance, wholly or partially, for the full-load conditions. Then ascertain the voltage rise at no load. These extremes will show the voltage variation and hence the line regulation.

In order to make clear the rather complex factors which enter into the case, we shall treat each one separately. First let us consider self induction. The term self induction applies to any electric circuit conveying an alternating current, and signifies the counter electromotive force produced against the original pressure, by reason of the change in magnetic lines. The electromotive force of self induction is calculated by means of a factor termed the "coefficient of self induction" called the henry, which represents the flux per unit of current. The reactance of a circuit is expressed by the equation.

$$X = 2\pi f L$$

where

f=frequency in cycles per second.

L=coefficient of self-induction in henries.

For the benefit of those not familiar with the derivation of the coefficient L, the following from Dr. Steinmetz may be helpful.

Consider two line conductors, such as shown in Fig. 4. Dealing with absolute units we have by definition, that if the magnetizing force for unit current at unit distance is i, then unit magnetizing force at x distance is

$$F = \frac{i}{2\pi x}$$

If the intensity of the field is H then

$$H = 4\pi F = \frac{2i}{x}$$

The magnetic flux of an element $d\phi$ and of length l is expressed by the equation

$$d\phi = H\, l\, d\, x = \frac{2\, i\, l\, d\, x}{x}$$

The total magnetic flux between the two conductors is found by integrating between the limits D and r, which takes the form:

$$\phi = \int_r^D d\phi = 2\, il \int^{\cdot} \frac{dx}{x} = 2\, il \log_e\left(\frac{2D}{r}\right)$$

This expression neglects the flux within the conductors themselves.

The coefficient of self induction then is

$$L = \frac{\phi}{i} = 2\, l. \log_e\left(\frac{2D}{r}\right) \text{ absolute units}$$

$$= 2\, l \cdot \log_e\left(\frac{2D}{r}\right). 10^{-9} \text{ henries}$$

The reactance

$$x = 2\, \pi\, f\, L$$

$$= 4\, \pi\, f\, l \cdot \log_e\left(\frac{2D}{r}\right) \text{ absolute units}$$

$$= 4\, \pi\, f\, l \cdot \log_e\left(\frac{2D}{r}\right) .10^{-9} \text{ ohms}$$

Reduced to commercial form, including the magnetic lines within the conductor the expression for inductance per wire per mile.

$$L = \left(80.5 + 740 \cdot \log_e\left(\frac{D}{r}\right)\right) 10^{-6}$$

For a three-phase line the inductance per mile of circuit

$$L = \left(139 + 1{,}280 \cdot \log_e\left(\frac{D}{r}\right)\right) 10^{-6}$$

With non-magnetic wires, such as copper and aluminum the expression for a three-phase line is

$$L = \sqrt{3}\left(.01524 + .14 \cdot \log_{10}\left(\frac{D}{r}\right)\right)$$

millihenries per 1,000 feet of circuit, where D and r are the distance and the radii of conductors in inches respectively, and the logarithms are the common or Briggs system with 10 as the base.

The calculation of the capacity will be taken up in the next issue.

(To be continued.)

[EDITOR'S NOTE.—This important series of articles was started in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN, September 3, 1910, and will cover every phase of central-station design. The treatment is elementary and withal practical throughout, and the complete series will constitute a standard and reliable treatise on this important subject.]

Long-Distance Transmission in Italy.

The development of hydroelectric works in Italy was at first almost exclusively carried out in connection with low-pressure installations in the low-level tracts of country in the neighborhood of the centers of consumption, and was subsequently extended to high-pressure installations in the mountainous districts where the quantity of water is small and the fall very considerable. The high-pressure line of the Brusio works, from Campocologno to Lomazzo, traversed a distance of 112 miles, and involved an outlay of $1,600,000, or $100 per kilowatt available at the place of consumption, so that the line cost one-half of the average cost of $200 per kilowatt reckoned for hydroelectric works (concession, waterworks, turbines, electric machinery, conductors, etc.) in Italy. Other long transmission lines have been installed since the Brusio works commenced in 1906. The Società di Elettrochimica has a line 112 miles long near Naples, and the Adamello Company has a line in the district of Parma of 136 miles. The pressures used on these two lines are 88,000 volts and 72,000 volts, which were, until recently, the highest in Europe; in addition to being able to use a smaller cross-section of copper and having smaller losses in transmission, it is not necessary to have so many supporting masts, the distances separating which have gradually grown from 200 feet in 1899 to 600 feet in the case of the Adamello line. These installations have only been in operation for a short time.—*Electrical Review, London.*

ELECTRIC LIGHTING and ILLUMINATING ENGINEERING

MERCURY-VAPOR QUARTZ LAMPS.[1]

BY MAURICE LEBLANC, JR.

The appearance of quartz mercury-vapor lamps marks one of the greatest steps made during the past few years in the science of lighting, from an economical standpoint.

In these lamps the luminous action is effected by a mercury arc which plays between two mercury electrodes in a vacuum tube made of quartz. The starting is accomplished as in Cooper Hewitt lamps, by tipping. In lamps for commercial illumination this tipping is accomplished by the automatic operation of an electromagnet, so that the starting is as simple as in an incandescent lamp or the carbon arc lamp. It is so arranged that starting is accomplished by the simple throwing of the switch.

The advantage of these lamps is in their high efficiency, which reaches 0.25 to 0.30 watts per candlepower. This efficiency has formerly only been reached by flaming-arc lamps, but, in their case, at the price of considerable inconvenience. They are difficult to regulate, use up the electrodes rapidly, are costly to replace, and requires frequent cleaning of the globes. On the other hand when the quartz lamps are once put in service they can be let alone for a long time. They are certain to burn a thousand hours and their life is often much greater than this, and moreover they require no cleaning of the globe. All these advantages together—a high luminous efficiency, infrequent replacement, zero maintenance cost—make the quartz lamp, in spite of its somewhat high price owing to the considerable expense of the material, the most economical means of electric illumination.

From the curve shown in Fig. 1 it is easy to see the reason why glass has been replaced by a material as expensive as fused quartz. This curve shows how the specific consumption of a mercury-vapor lamp (number of watts per candlepower) varies with the pressure of mercury vapor in the tube. To raise this pressure it is only necessary to prevent cooling off of the lamp, for as the temperature rises the pressure naturally increases.

It is easily seen that this consumption, after having passed a minimum A for the pressure of the order of one millimeter, then increases, passes a maximum, again decreases, and reaches at a pressure of about one atmosphere, a value smaller than that of the minimum A. The Cooper Hewitt lamp operates near the minimum A, which is the best that can be done with a mercury-arc lamp in an enclosing tube of glass. To reach values lower than that of this minimum, pressures of vapor are necessary which require a temperature corresponding to the melting point of glass. Quartz, which does not melt below 1,800 degrees centigrade, can resist these temperatures, and for that reason it has been selected in spite of its somewhat high cost.

This high temperature has moreover the advantage of improving somewhat the color of the mercury arc which is so characteristic of the Cooper Hewitt lamp; the color becomes more yellow, something like that of certain flaming-arc lamps.

The spectrum of the mercury arc is very rich in ultra-violet rays; in the Cooper-Hewitt lamp these rays are stopped by a glass enclosing tube, but on the contrary the quartz tube allows them to pass. For this reason the quartz lamp constitutes a much richer source of ultra-violet rays and it is therefore much easier to use in connection with sterilization work and chemical industries which utilize the action of such radiation.

If these lamps are used for illumination it is customary to surround the burner with a glass globe which completely intercepts the ultra-violet rays so that the use of the quartz lamp thus protected does not endanger the eyes of the beholder.

The substitution of quartz for glass has introduced in the manufacture several somewhat serious difficulties. The most important of these is found in connection with getting the conducting wires inside of the containing tube through a seal which will allow the maintenance of a vacuum. With the glass containing tubes (Cooper Hewitt lamps, incandescent lamps, and X-ray lamps) it has been customary to seal a platinum wire in the glass as the coefficient of expansion of platinum is very close to that of certain glasses. With quartz this cannot be done, as the expansion of the quartz is only about 0.4 micron per degree per meter, or about one-twentieth of that of platinum, which is eight microns. Conse-

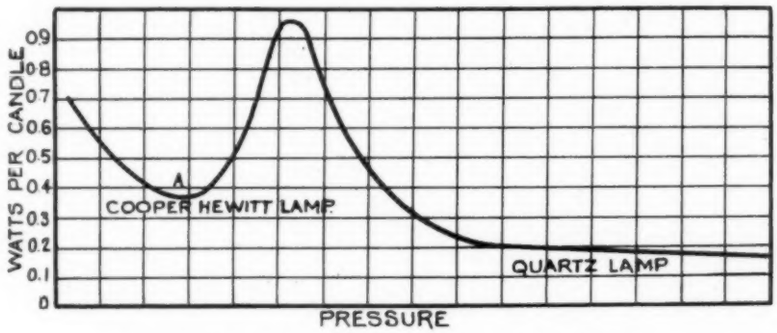


FIG. 1.—VARIATION OF EFFICIENCY WITH PRESSURE.

[1] Translated and abstracted from *La Lumiere Electrique.*

quently, when platinum wires are sealed in, the seal will break after a short time. This difficulty has been overcome by the use of invar. Invar is a nickel-steel alloy which has a very small coefficient of expansion, about 0.8 of a micron per degree per meter. Unfortunately invar is a forged metal, which loses its properties when heated to a red heat so that it is quite impossible to seal it in quartz. A means has been devised, therefore, of putting an invar stopper into a conical quartz tube, much as a glass bottle is sealed. As such a seal might leak air it is covered with mercury, which insures a hermetically sealed joint, and to prevent this mercury from spilling out it is covered with a solid cement. This joint is shown in Fig. 2.

Another difficulty comes from the fact that in mercury arcs the fall of potential at the surface of the anode is greater than at the surface of the cathode, so the anode is always hotter than the cathode and consequently little by little mercury is taken over from the anode to the cathode. At first sight the most simple process to prevent the

FIG. 2.

accumulation of mercury at the cooler electrode would seem to be to place the tube at a slant so that the cooler electrode would be higher than the hotter one. Then when the mercury accumulated, it would overflow and run into the lower electrode. Unfortunately in a quartz lamp such movements of liquid mercury tend to extinguish the arc. The reason for this is that the comparatively cool mercury at the electrode in passing into the very hot illuminating tube vaporizes, which results in a rapid increase of pressure, causing the extinction of the arc.

It is then necessary to find a compensating device which will maintain the levels of the two electrodes at about a constant height in spite of their difference in temperature. The means found of doing this consist in connecting the negative electrode to the main tube by a conical tube, the top of

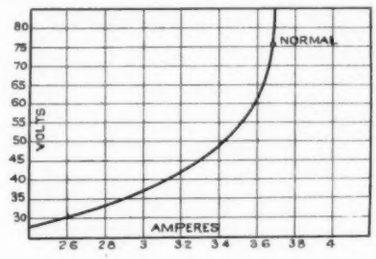


FIG. 3.

which joins the main tube. If the mercury accumulates at the negative electrode the level in the cone rises. The arc starts from a surface which becomes smaller and smaller and heats increasingly and evaporation becomes more active, thus opposing the accumulation of mercury. If the level becomes lower in the cone the process is reversed and in practice with a properly dimensioned cone the scheme works perfectly.

The quartz tubes are of small dimensions and the number of watts necessary is somewhat high, being 320 watts in the 110-volt model, and 560 watts in the 220-volt model, so it is necessary to insure the cooling of the tube if it is desired to keep the pressure of the mercury within proper limits. Cooling is secured either by surrounding the electrodes with metallic wings which dissipate the heat as a radiator, or by furnishing the tube with a chamber in which the mercury condenses, going back into the tube in liquid form. The performance of the lamps varies slightly with the external temperature, for when it is cold the cooling is more marked and the current which passes into the tube for the same difference of potential at the terminals is greater. These variations of action are more noticeable in the tubes where cooling is accomplished by radial wings. In the case of the type with a chamber of condensation the temperature of this chamber is always high enough so that the heat which it dissipates is but little influenced by the relatively small variations of the external temperature.

Fig. 3 represents the characteristic curve of a 110-volt lamp, and it is seen that the curve becomes somewhat rapidly parallel to the axis of volts near the point of normal operation. The 110-volt lamp operates with 75 or 80 volts at its terminals, the difference being absorbed in a resistance connected in series. An examination of the character of the curve shows the necessity of making the adjustment of the series resistance with the aid of a voltmeter connected to the terminals of the tube. An adjustment made by measuring current is not sufficiently exact.

At the moment of lighting the cold tube the interior pressure is very low and consequently the number of volts drop is small, as the series resistance has a value which will be correct when the tube is in full operation and the current is at its normal value. Fig. 4 shows how the current and the voltage vary at the terminals of a 110-volt lamp whose series resistance is arranged for operation at eighty volts and four amperes.

When the lamp in operation is extin-

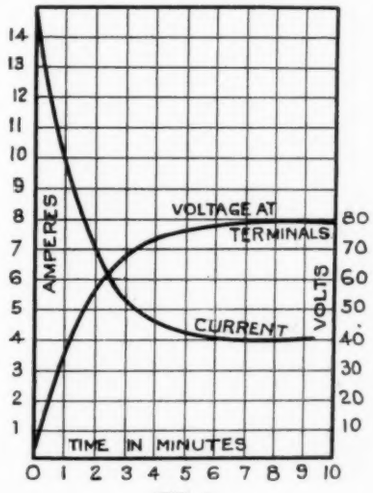


FIG. 4.

guished by too great a variation of voltage on the line, it is immediately relighted and put in operation if provided with an automatic starter. The necessity for the lamp to be able to relight itself under these conditions is one of the reasons which limits the voltage at which it normally operates. It may be seen from the curve that it would otherwise be most economical to operate at the highest possible pressure.

If a quartz lamp is operated at higher and higher voltages a value is finally

reached which is called the critical point beyond which the lamp cannot burn without first being cooled. At the moment of tipping, the mercurial short-circuit is produced and as the lamp goes back into position, the arc is drawn, but it is extinguished before reaching from one electrode to the other, and the reason for this is as follows: In proportion as the tube burns at higher voltages, the lamp becomes hotter and at the moment of tipping the cold mercury of the electrode runs into the illuminating tube and produces an intense vaporization which raises the pressure to such a value that a higher voltage than that of the line would be necessary in order to successfully establish an arc. This explanation is confirmed by the fact that the critical point for a tube of the 110-volt type, which would be, for example, ninety-five volts when on a 110-volt line, is raised to 120 volts when burning on a 220-volt line.

New York Section, Illuminating Engineering Society.

Architects' Night might almost be applied to the meeting of the New York Section of the Illuminating Engineering Society that was held on the evening of December 8 at the Engineering Societies Building.

The chairman, Dr. A. H. Elliott, first called upon the local secretary, A. J. Marshall, to abstract the first paper, "Some Notes on the Early History of Photometric Standards," by Prof. Edward L. Nichols, as the author was unable to be present.

EARLY HISTORY OF STANDARDS OF LIGHT.

Prof. Nichols' paper deals with the development of various standards of light previous to 1884, at which time the Hefner lamp was perfected and the first international agreement on a light standard was concluded. Attempts to use the candle as a photometric standard began in the eighteenth century. Bougner and Lambert made use of it in a rather crude way, but Rumford in 1794 conceived its true worth and shortcomings as a standard; he used Argand lamps as secondary standards. In 1860 the English parliament legalized its use. The German Vereins-kerze was standardized in 1882 after fourteen years of work in trying to perfect it. All candles are very imperfect as standards, however. The Carcel lamp was developed in France and used as a standard as far back as 1822, being later legalized for this purpose. Incandescent platinum as a standard was first proposed by Draper in 1847; this idea was developed among others by Violle in 1879. The Harcourt pentane lamp was brought out in 1877; the gas standard of Methven and Giroud in 1878 and 1882, respectively. The light from the positive crater of the carbon arc has been proposed by several scientists.

The other paper of the evening on "The Lighting of the Allegheny County Soldiers' Memorial Building" was presented by the author, Bassett Jones, Jr., who thoughtfully provided many interesting lantern slides.

LIGHTING OF ALLEGHENY COUNTY SOLDIERS' MEMORIAL.

The lighting of this memorial building is described by Mr. Jones in a very modest manner, although it is truly resplendent with many of the most wonderful effects ever achieved in interior lighting. The architectural design of the exterior is of an imposing character and the interior is rich with its multi-colored decorative designs. The auditorium occupies the center of the building and is illuminated by night through its beautiful paneled ceiling with a variety of electric light sources, producing several different colored lighting effects, harmonizing with, and, in fact, enhancing the architectural design. There are used over different portions of the ceiling flaming-arc lamps, mercury-vapor lamps, Moore tubes, tungsten and carbon incandescent lamps; these are separately controlled. When all are used together an illumination of over four foot-candles is produced on the main flour. The lamps are mounted in the space taken by the trusses directly over the ceiling and are provided with various reflectors throwing the light through the glass panels of the ceiling. Above the auditorium is the banquet hall, which is also lighted by lamps over its glass-paneled ceiling, only tungsten lamps being used, however. The entrance foyer has a system of cove lighting. Other rooms are lighted by means of bronze fixtures bearing tungsten lamps.

The discussion was opened by Henry Hornbostel of the firm of architects who designed the building. He felt that the improvements in the light sources had made it possible for the designers to seek and obtain effects where at an earlier time light enough to enable us to see was about all one could expect.

This was especially true where color effects were desired, there being seven or eight sources now available which differed widely.

Mr. Jones called attention to the fact that the flame-arc lamps which were operated on sixty-cycle currents produced a musical note, low D, which was discovered during a concert being given by the Philharmonic Orchestra.

The discussion which followed did not not bring out much that was new but Messrs. Jacoby, Comstock, Stickney and Taylor had much to say in praise of the installation.

Water Power of British Columbia.

Fred F. Henshaw, of the United States Geological Survey, is quoted as placing the total of the water powers of British Columbia at low waterflow, at 8,000,000 to 10,000,000 horsepower. By judicious storage this amount may be greatly increased.

Brooklyn Company Section, National Electric Light Association.

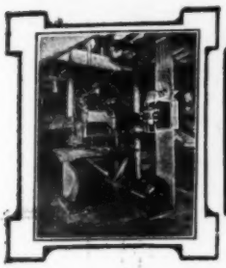
Public Service Commissioner Edward M. Bassett, of the First District New York Commission, delivered an address on December 5 before the Brooklyn Company Section of the National Electric Light Association at its regular monthly meeting, in the course of which he said:

"Efficiency in a public-utility corporation redounds not only to the benefit of the public, but should redound to the benefit of the corporation itself. The saving that comes from thrift, the greater earning capacity that comes from ingenuity and faithfulness, is properly divided between the public and the corporation itself, not forgetting the payment of good wages, and the making of permanent and promising positions for those that contribute to that result. I for one am of the opinion that public regulation should incite and increase and encourage private initiative, thrift, economy, better results for a certain amount of work, more electricity for a certain number of pounds of coal, and that that efficiency should not entirely, or anywhere near entirely, be taken advantage of by the public, but the corporation that can produce results is entitled to a large measure of the benefits of its own efficiency and progress.

"Public regulation will in no sense be a success until that principle is largely recognized, because you cannot make all companies the same. If you try to make all the same it will be pressing down the capacity to the level of the poorest, rather than the raising up, or the endeavor to raise up, the capacity of all to that of the highest, and profit for the investor, payment of good wages, and the ability to pay good wages to the workmen, must be encouraged by the State, representing all the people."

President E. A. Baily of the Company Section presided at this meeting, which was attended by nearly 400 members.

After the address by Commissioner Bassett, two papers were presented and discussed: "Notes on Power-Station Economy," by H. P. Wood, and "The Follow-up System of a Purchasing Department," by H. F. Frasse. Selections were rendered throughout the evening by the Ridge Court Orchestra, composed of employees of the Edison Company.



Industrial Power

Motor Drive in an Elastic-Web Mill.

A recent installation of induction-motor drives in an elastic-web mill is of interest for two reasons. In the first place, the motor drive was installed instead of enlarging the present steam plant which uses natural gas at only ten cents per 1,000 cubic feet, and in the second place, the style of looms and the method of weaving are out of the ordinary.

The installation was made in the plant of the Mansfield Elastic Web Company, who manufacture elastic webbing such as is used in surgical bandages, suspenders, etc. In the web looms the warp consists of threads and rubber bands under tension. While weaving, the rubber is under tension, but when released the rubber strands pull back, giving the material a solid appearance such as any woven textile. These looms contain from twenty to forty shuttles sliding in slots somewhat similar to ribbon machines. The weave is made up entirely of cotton or wool yarns.

For a number of years the original mill of the company has used gas-fired boilers and steam engines, with the usual belt and shafting transmission, and when, about a year ago, it was decided to enlarge the plant, making it more than double its former capacity, it had fully been decided upon to enlarge the steam plant and to extend the shaft and belt drive to the new factory. However, the mill owners were finally convinced of the economy and advantages of electric-motor drive.

In the new building there are about thirty-five looms averaging forty shuttles each, and in the old plant, which is still being run by steam, there are twenty-four looms averaging twenty-nine shuttles each. Thus in the new plant there are practically twice as many shuttles as in the old. However, the cost of running the new plant is less than half of the present cost of running the old plant. For instance, the average bill for power in the new building for the past three months has been about $46 per month; while the bill for gas in the old plant was $43 per month, and to this must be added the engineer's salary of $60 per month. In addition to this, there are further charges against the old plant as follows: $5 per month for water and $3.50 per month for oil over what it costs to lubricate the machinery in the new plant. Thus, the cost of power in the old plant is $65.50 per month more than in the new plant, and at the same time, twice as many shuttles are being run in the new plant.

These figures would be considered remarkable even when comparing a steam plant using coal at $2.50 per ton with an electrically driven plant. However, they are still more notable when it is considered that the boilers in the steam plant are fired with natural gas, which costs only ten cents per 1,000 cubic feet.

The output of the two halves of this plant is also greater than two to one in favor of the electric drive, inasmuch as the motor-driven looms are run at least ten per cent faster than those in the old mill. This higher speed is possible because the motor runs at a uniform angular velocity, practically eliminating breakage of the warp. It is also, further, due to the fact that the motors are at all times directly under the control of the operator inasmuch as one operator, who tends two looms, can instantly stop or start either loom from either end. This control is accomplished by having a long rod extending across the entire width of the looms. The operator is further assisted by the fact that in case one of the rubber strands breaks, an electric contact is made which sounds a bell.

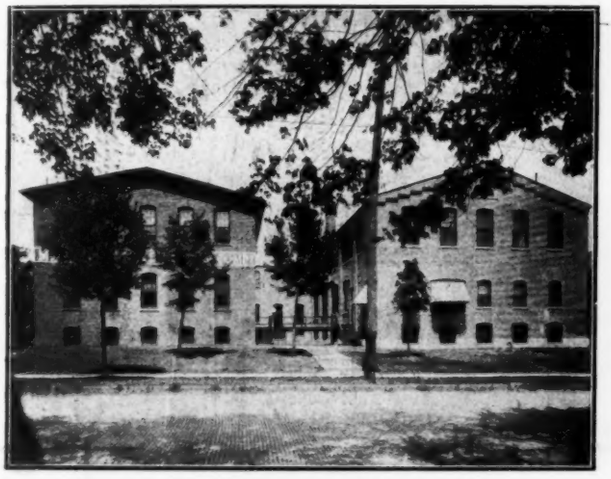


FIG. 1.—MANSFIELD ELASTIC-WEB MILL.

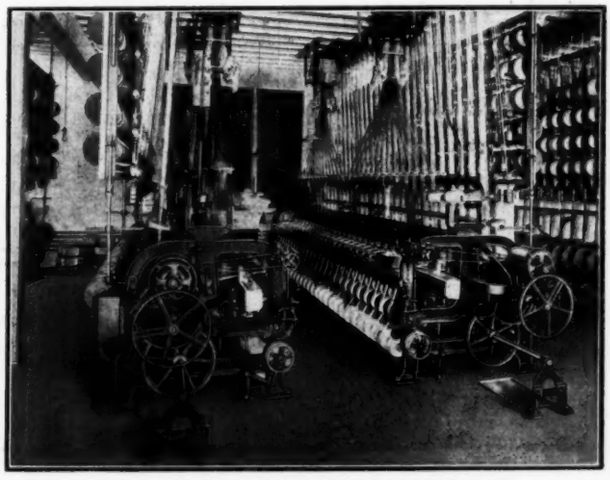


FIG. 2.—MOTOR-DRIVEN LOOM.

A good idea of the new plant may be gained from Fig. 4 which shows a line of the new looms equipped with motors. Those motors are mostly of two horsepower and are not provided with any starters or compensators, but are switched directly upon the line and allowed to run continuously throughout the day. When an operator stops a loom, he merely throws out a clutch allowing the motor to run idle for a short time.

Besides the reduced cost of producing power, as noted above, the Elastic Web Company has also noticed other desirable features about the motor drive. In the first place, the rooms are much lighter, due to the elimination of shafting and belting. This can be readily seen by comparing Figs. 3 and 4, giving a view down similar aisles of two practically identical rooms, except that one is equipped with belts and the other with motors. Besides the main shafts, it is also necessary to have a jack shaft run across the building between each pair of looms. This is necessitated by the fact that two looms are placed back to back and are necessarily driven from alternate ends. These shafts running entirely across the building between each pair of looms also consume an enormous amount of power and are continually spoiling material by dropping oil and grease upon the finished product. The motor drive has, of course, eliminated this trouble also.

Another point is that it is much easier to keep the new mill clean, as the fuzz given off by the looms is not being continually churned up and thrown about by the swiftly moving belts and pulleys.

One of the advantages of motor drives that has found most favor with the Elastic Web Company is that a given machine can be threaded up for special work and run day and night to fill an order, making it unnecessary to keep up the boiler and have the engineer present and run the line of shafting throughout the entire mill.

Up to the present time forty-seven motors have been installed in the plant and the looms in the old plant are being equipped one by one with motors, business making it such that more than three or four looms cannot be laid off at one time. Most of the motors are two horsepower, with a speed of 1,120 revolutions per minute. Several three-fourths and several three-horsepower motors are in use on special looms.

The motors installed in this plant were furnished by the Ideal Electric & Manufacturing Company.

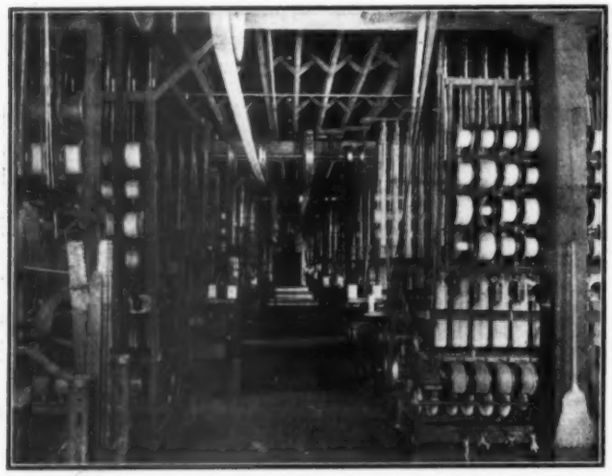


FIG. 3.—VIEW OF LOOMS BEFORE INSTALLING MOTORS.

FIG. 4.—LOOMS AFTER INSTALLING MOTORS.

First Exhaust Turbines in Canada.

The erection of a new exhaust-steam turbine engine at the Colliery of the Dominion Coal Company at Glace Bay, is practically completed, and within a few days, just as soon as some necessary changes are made in their power plant by the company, the new engine will be turned over to the company by the manufacturers.

The new engine will furnish power for all the company's plants to the extent of 1,400 horsepower from what has heretofore been waste steam from the other engines about the colliery. This engine is the only exhaust steam turbine installed in Canada, the Dominion Coal Company being the first to install such an engine which means a big saving in steam power.

The Nova Scotia Steel & Coal Company are following in the wake of the Dominion Coal Company, and will install two 680-horsepower low-pressure turbines at their works in New Glasgow generating electricity for their plant, by using exhaust steam from their rolling mills.

Electric Power in a Japanese Paper Mill.

At Tomakamai, Japan, there was recently completed a paper-mill plant, at a cost of $4,000,000, which makes extensive use of electric power in all operations.

According to a recent consular report, the cost of electrical machinery in this plant, all of which was imported from America, is placed at about $1,000,000. This does not include the cost of the hydroelectric plant, located fourteen miles distant at Lake Shikatsu, which supplies current to the mill. This plant has a generating capacity of 22,000 horsepower.

The motor equipment in the Tomakamai mill comprises five 750-horsepower motors, four 450-horsepower motors and forty-three motors ranging in size from 100 to 200 horsepower.

The Los Angeles *Times* has placed an order for a complete equipment of electric motors and other electrical apparatus to be installed in its new printing plant which has recently been rebuilt following a disastrous fire.

FLOATING BATTERY.—What is meant by a floating battery? How and where is it used?—M. Q., Manhattan, Kan.

A floating battery is a storage battery connected across a line whose voltage fluctuates considerably due to large, sudden and frequent load changes, such as in electric railway and elevator service. It is used to regulate the voltage and to relieve the generators of these sudden peaks. A floating battery is usually installed at some distance from the generating plant. The number of cells is such that the voltage of the battery is higher than that of the line when the load is heavy and the line drop consequently great; the battery then discharges and thus carries some of the momentary peak. When the load and line drop are small the voltage of the line is greater than that of the battery and the latter is therefore charged, thus keeping the generator load and line voltage relatively constant compared to what they would be without the battery. A floating battery does not need to be of such large capacity as one intended for carrying a prolonged peak of an hour or more. A battery for the latter service is not regarded as a floating battery, although it may float on the line for a considerable part of the day and thus act as an automatic voltage regulator. As a rule, a floating battery needs no booster for aiding its charge, since the latter is entirely automatic, and the charge and discharge follow each other at short intervals. The efficiency of a floating battery is higher than that of a battery used for central-station peak-load service and, in fact, higher than that of any other storage battery.

MOTORS FOR FLASHERS.—I have been told that unless care is taken in the selection of a motor for a sign flasher, the motor is liable to race and destroy itself. Is this true and, if so, why? What kind of motor should be used?—R. S. L., Peoria, Ill.

Racing of a motor in this service is possible if it be a direct-current series motor and the belt or connection between it and the flasher should break. Such a motor will race when its load is suddenly removed. If a motor of this type has to be used it would be well to use a sprocket chain or gears in connecting it to the flasher, not because a belt would not serve to drive the light load that a flasher should be, but in order to make a more infrangible connection. If a direct-current shunt motor is used this is practically obviated, for such a motor would race only on a break in its field circuit while operating, which is very unlikely, but could be guarded against by placing a no-load release magnet in its field circuit. With an induction motor all these contingencies are eliminated, for such a motor never exceeds a speed greater than the synchronous limit.

HIGH-TENSION OVERHEAD WIRES IN CITIES.—Is it customary to use insulated wire for high-tension overhead lines where they run through a town or city? Is it necessary to run the line around the edge of the town if bare wire is used?—W. L. F., Little Rock, Ark.

It is not customary to insulate such high-tension lines. Many towns will not permit the entrance of high-tension overhead lines of more than 10,000 volts, whether bare or insulated. If such lines do enter a city, insulated wire is no better than bare wire, sometimes, in fact, worse, because it gives a lineman a false sense of security, whereas a bare wire would put him on guard. Insulation that would remain effective and weatherproof would be prohibitory in cost. Although high-tension overhead lines are invariably constructed in a much more substantial manner than those of moderate pressure and are therefore almost equally safe, it is not advisable to run them through a city because of the danger to the ubiquitous small boy, whom it is difficult to keep from climbing poles despite warning signs. Therefore, underground construction is the best policy in densely built communities, and passing around or through the outskirts is best in small towns. While such lines have been built through cities they have been of bare wire and are gradually being put underground.

CHRISTMAS-TREE LIGHTING.—Is it practical to light a Christmas tree from dry batteries? I have seen such outfits advertised, but have doubts of their value for such lighting.—H. E., Grand Rapids, Mich.

It is quite practicable to use dry cells for Christmas-tree lighting, although, of course, the results are not as satisfactory as with a storage battery or by using a number of lamps in series on the ordinary 110-volt house-lighting system. Dry cells will not maintain their voltage on closed-circuit work, such as lighting lamps, because of polarization. The brightness of the lamps will therefore diminish after several minutes of steady lighting. If the circuit is then opened and the cells given a chance to recuperate, the lights may be again turned on. The length of time that the lights may be run depends on their size and number, since the larger this number the greater the load on the battery and more rapid its exhaustion. It will be better to use twelve to sixteen-volt miniature lamps instead of a lower voltage; this will require eight to eleven cells in series, but with lamps of the same candlepower the current required varies inversely as the voltage. The great advantage of dry cells for this purpose is their cheapness and convenience. Moreover, if not too greatly exhausted, they may later be used for bells, buzzers and other miscellaneous purposes.

CURTIS TURBINES.—What American companies manufacture the Curtis steam turbine for driving electric generators?—S. P., Duluth, Minn.

The Curtis steam turbine is manufactured in this country only by the General Electric Company, Schenectady, N. Y., for all purposes except the propulsion of steamships and airships.

FINANCIAL REPORTS OF ELECTRICAL COMPANIES.

NORFOLK & PORTSMOUTH TRACTION COMPANY.

The report of the Norfolk & Portsmouth Traction Company for the month of October and four months ended October 31, 1910, compares as follows:

	1910	1909
October gross	$166,776	$156,540
Expenses	100,992	87,974
October net	65,784	68,566
Charges and taxes	61,098	62,416
October surplus	4,686	6,150
Four months gross	724,574	669,211
Expenses	406,577	373,846
Four months net	317,996	295,365
Charges and taxes	255,396	251,943
Four months surplus	62,600	43,422

FORT WAYNE & WABASH VALLEY.

The report of the Fort Wayne & Wabash Valley Traction Company for the month of October and four months ended October 31, compares as follows:

	1910	1909
October gross	$ 131,360	$ 122,806
Expenses	67,366	70,386
October net	63,994	52,420
Charges and taxes	45,829	42,284
October surplus	18,165	10,135
Ten months gross	1,266,085	1,161,156
Expenses	706,280	678,925
Ten months net	559,805	482,231
Charges and taxes	451,383	423,729
Ten months surplus	108,423	58,501

TWIN CITY RAPID TRANSIT.

The report of the Twin City Rapid Transit Company, for the month of October and ten months ended October 31, 1910, compares as follows:

	1910	1909
October gross	$ 645,358	$ 596,963
Expenses	308,743	277,175
October net	336,615	319,788
Charges, taxes & preferred dividends	140,321	140,251
October surplus	196,294	179,537
Ten months gross	6,265,727	5,773,383
Expenses	2,996,849	2,709,742
Ten months net	3,268,877	3,063,640
Charges, taxes & preferred dividends	1,401,974	1,388,761
Ten months surplus	1,865,903	1,674,879

MASSACHUSETTS ELECTRIC COMPANIES.

The Massachusetts Electric Companies report for year ended September 30, 1910, states that the consolidated income account compares as follows:

	1910	1909
Gross	$8,560,449	$8,052,355
Expenses	5,360,295	5,158,396
Net	3,200,654	2,903,958
Charges	1,792,936	1,778,128
Balance	1,407,717	1,125,829
Dividends	1,130,561	1,000,464
Surplus	277,156	125,365

Report of Electrical Department of the Sanitary District of Chicago.

The Electrical Department of the Sanitary District reports for the first nine months of 1910 a gross income of $409,960. The operating expenses amount to $115,887; depreciation, $55,181; the fixed charges are given as $126,049, leaving a profit of $112,843.

Western Electric Company.

In a communication to stockholders, President H. B. Thayer, of the Western Electric Company, states that for the fiscal year ending December 31, next, directors have voted to declare an extra cash dividend of two per cent, payable December 31 to stock of record December 24. This, with the regular eight-per-cent dividend, makes ten per cent for the year, and gives the American Telephone Company as owner of eighty per cent of the $15,000,000 stock additional income of $250,000.

The Electron Theory of Conductivity.

According to the electron theory of the late P. Drude (1900) the conductance of metals for heat and electricity is due to the free electrons, which are subject to the kinetic gas laws, and the ratio of thermal conductivity to electron conductivity should be constant for different metals. The theory involves knowledge of the number of gaseous molecules per gramme and of J. J. Thomson's elementary electric charge. The theories of Riecke and of Reinganum differ somewhat from that of Drude, but the ratio of the two conductivities is agreed to be of the order of 10^{-10}. As this ratio has more particularly been investigated by Wiedemann and Franz, the constancy law is frequently associated with their names. Recent metallographical researches now show that metals of the platinum group give too small a ratio, and metals like bismuth and iron too high a value. Most alloys, especially those which form mixed crystals in solid solutions, also show too high a ratio—i.e., their electric conductivity is relatively too small or their electric resistance too great. The behavior of alloys has been studied by Rudolf Schenck (*Annalen der Physik*, vol. 32, page 261). The electric conductivity of an alloy might become smaller than that of the pure metal, either because the foreign metal binds some electrons and diminishes the number of free electrons, or because it increases the internal friction of the solvent. Riecke favors the first assumption, Schenck the latter; the dissolved metal absorbs kinetic energy in its slow diffusion, and that should become discernible in the change of the optical and thermo-electric properties observed on adding another metal to a pure metal.—*Engineering.*

AMONG THE CONTRACTORS AND SUPPLY MEN

To know what is going on among the men who do things and those who supply the material for the doing is always interesting. The actual happenings of the day with the contractors and the men who furnish them with supplies of all kinds, accurately reported from all parts of the country, is the object of this department.

F. W. RIDGEWAY, Freeport, Ill., received the contract for installing boulevard lamps on Galena Street of Freeport.

THE BRAYTON ELECTRIC COMPANY, of Utica, N. Y., was recently incorporated to do a general contracting business. The company is capitalized at $5,000, and its directors are M. Jesse Brayton, Susan E. Brayton and John F. Griffin, of Utica.

THE LIGHT SUPPLIES AND CONTRACTING COMPANY has been incorporated at La Porte, Ind., by Chas. Kimble, Al Clark and Frank Felton. The main business of the company will be the sale of fixtures and electrical appliances and the wiring of houses.

THE WATSON FLAGG ENGINEERING COMPANY, of New York, was awarded the contract for installing the lighting plant at the County Court House at Newark, N. J. The plant will cost $26,495, and beside lighting the building, will furnish power for ventilation and for the operation of the elevators.

THE UNION ELECTRIC COMPANY, Freeport, Ill., was awarded the contract for wiring the factories of the Arcade Manufacturing Company and for installating the generating plant. The entire plant of the Arcade Company will be wired and over a thousand lights installed. These lights will include the ordinary electric globes and also a number of large arc lights.

THE WHEELER-GREEN ELECTRIC COMPANY, Rochester, N. Y., has been awarded the contract for installing electric feeder cables, pipes and transformers, according to the plans of the State Architect, at the State Agricultural and Industrial School at Industry, N. Y. The contract price for the work is $16,000.

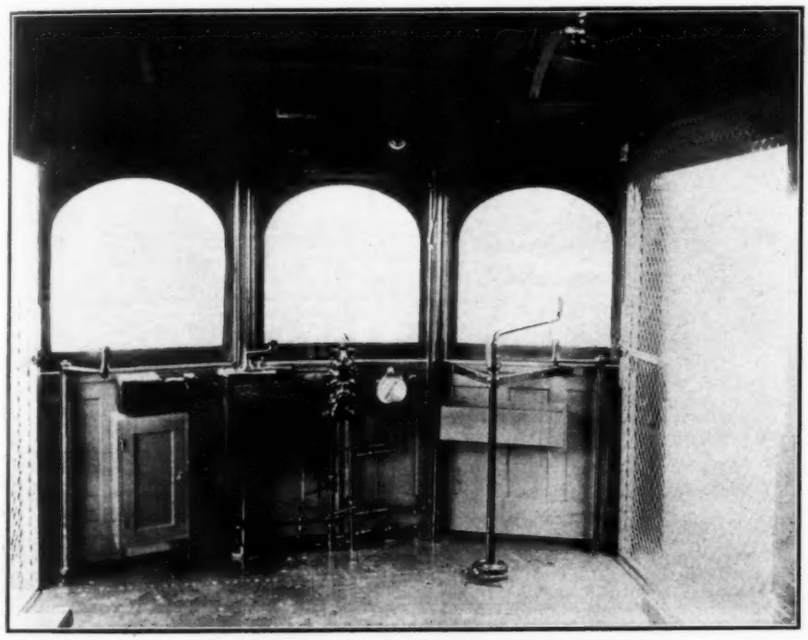
Oak Park Company Sold.

The North Shore Electric Company, of Chicago, has bought the Oak Park Light, Heat & Power Company, of Oak Park, Ill. The latter company has $600,000 bonded debt outstanding and an equal amount of capital stock.

New Electrical and Mechanical Apparatus and Appliances.

New Motor Car Equipment for Peoria Railway Terminal Company.

The Peoria Railway Terminal Company has recently added five new, double-truck passenger cars to its rolling stock. This company operates a standard-gauge interurban electric line, connecting Peoria, Baryonville, South Bartonville, Hollis and Pekin. The new cars, fifty-seven feet over all and which when fully loaded weigh approximately forty tons, are of the single-end type. The car bodies complete with truck were built by the McGuire, Cummins Manufacturing Company. The trucks are equipped with thirty-six-inch wheels mounted on six-inch axles with seven-inch gear fit arranged for a gear ratio of 18.69. It is expected that when operating on normal schedule the single trip will include six stops in the interurban districts and an average of six or seven in the 2.8 miles of city running.



MOTORMAN'S STATION IN NEW MOTOR CAR.

Each car is fitted with a quadruple equipment consisting of four No. 304-A interpole railway motors, each motor having a nominal rating of seventy-five horsepower at 500 volts or ninety horsepower at 600 volts. All the important characteristics which through long tests of service have won favorable recognition wherever they have been introduced are embodied in these motors, namely, split frames, separate oil-gauging reservoirs, waste-packed bearings, detachable bearing housing with provision for holding the armature in normal position while lower half of frame is dropped for examination, strap-wound coils for field and armature, and two-point gear-case suspension.

The Westinghouse hand-operated unit switch control is used on each car. The line switches and each unit of the control switch is actuated by air under pressure of seventy pounds per square inch. The only current flowing through the master controller is the small amount required to energize the electro-magnetically operated needle valve which admits air to the air cylinders of the switch. With the electro-pneumatic control a uniform reliability of operation is assured independent of fluctuations of line voltage. It can be used without risk of injury under conditions where the excessive current resulting from low line voltage would result in seriously burning or welding the contacts of any other type of switch. Both the motors and control were made by the Westinghouse Electric & Manufacturing Company.

Large Hydraulic Turbine Installation.

The engineering world will be interested to learn that contracts have recently been awarded for the building of two hydraulic turbines, which, it is said, will be the largest in the world. The Stone & Webster Engineering Corporation, acting as consulting engineer for the Pacific Coast Power Company, has placed an order with Allis-Chalmers Company for two 20,400-horsepower reaction turbines to be installed in connection with a new development on the White River.

This development is one of the most comprehensive undertaken on the Pacific Coast, and the problems which have confronted the engineers have been extremely interesting as well as complex. The White River is fed by the glaciers of Mt. Ranier and receives its name from the milky silt which the river carries and which gives it a whitish color.

The development is about twenty miles east of Tacoma. The diversion dam is to be built at a point near the big viaduct of the Northern Pacific Railroad north of Buckley. This will not be of unusual size or strength and will simply serve to divert the water into a ditch discharging into a settling pond in which the silt will have a chance to be dropped. The headworks and gates will present some new features of design and will be made extremely strong. From the diversion dam the water will be carried through an earthen ditch about five miles long to the main storage reservoir. This storage reservoir is one of the most important elements in the entire development, as it will hold enough water to operate the plant for a period of three or four months should no additional water be received. It is to be made up of several existing lakes, which will be interconnected and which will have their capacities largely increased by the building of heavy embankments and masonry dams. The flow line of the reservoir will be about four miles long.

From the storage reservoir the water will be carried through a tunnel about 3,000 feet long to the head basin. At present only one tunnel will be

built, but eventually another will be added. From the head basin a separate steel pipe line will be built for each turbine. These lines will be approximately 2,200 feet long and will be eight feet in diameter at the upper end and six feet in diameter at the power house end.

The power house is designed for a total length of approximately 373 feet. Room is to be provided for six units, although only two will be installed at the present time. The other side of the building, twenty-six feet wide, will be given over to exciter units, pumps, toilet rooms and transformer bays. Concrete foundations will be employed with brick superstructure.

The hydraulic installations will be supplied by Allis-Chalmers Company and will consist at present of two units, which are said to be the largest ever built. These will have a maximum capacity of 20,400 horsepower each under a head of 480 feet. They will run at 360 revolutions per minute. Each turbine will be direct connected to a sixty-cycle, three-phase, 6,600-volt generator.

The turbine runner is of the high-pressure Francis type, with horizontal shaft. Water will be admitted to the runner through a cast-steel spiral casing. The runner, which will also be of cast steel, divides the water into two lines of flow, and it is discharged from the wheel by two quarter-turns to separate draft tubes. The flow of water to the turbine will be controlled by a cast-steel butterfly valve.

The spiral casing of this turbine will be the largest steel casting of this kind ever made. The butterfly valve is to be over seven feet in diameter, and will be the largest valve of this type ever used. The shaft, carrying the turbine runner, will be nearly two feet in diameter, and the bearings for it will be about 16 inches in diameter. All parts of the turbine which will have to withstand the operating pressure of the water will be tested in the shops under a pressure corresponding to about 900 feet head. To give an idea of the size and strength of the parts it is only necessary to state that the total testing load on the butterfly valve will be about one and one-half million pounds.

The governors for these turbines will be of Allis-Chalmers standard oil-pressure type, and the specifications call for extremely close speed regulation. Separate governors will be supplied for each unit, but a rather elaborate central oil-pressure system will be employed.

As this plant will have to regulate the supply of energy to the whole system of the Pacific Coast Power Company the problem of proper regulation is an important one. It becomes of still greater importance on account of the necessity of conserving the storage supply of water. To meet this condition and handle the water in a way which will protect the plant from injury and at the same time save water, pressure regulators will be installed. These are similar in design to those Allis-Chalmers Company is now installing on the 18,000-horsepower turbines in the Great Western power plant, a design which has done excellent service on other installations.

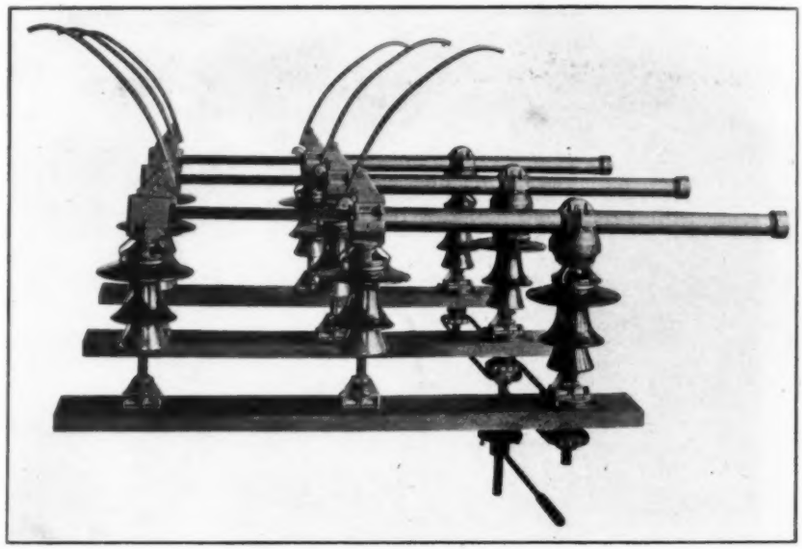
The size of the exciter units has not yet been definitely determined, but there will be two of at leat 500 horsepower each. One exciter is to be provided for each three units of the ultimate equipment. As the proportionate amount of water which these wheels will use is not large they will be of the impulse type, and will be governed by means of a deflecting hood similar to that used with the exciter units of the Kern River station of the Edison Electric Company, built by Allis-Chalmers Company.

Construction is progressing rapidly under the direction of the Stone & Webster Engineering Corporation.

Outdoor Disconnecting Switch.

The accompanying illustration represents a photograph of one of a new line of outdoor disconnecting switches which the General Electric Company is prepared to furnish for use on circuits up to 110,000 volts. These switches are claimed by the manufacturer to be thoroughly weatherproof and will act satisfactorily under all weather conditions. It should be particularly noted that this outdoor disconnecting switch does not in any way require special line construction, neither is it necessary to alter the spacing of the lines where they are connected to the switch since the contact blades in opening and closing move parallel to the direction of the transmission line.

The illustration shows the switch closed. When the switch is opened all the blades move parallel to one another into the pipes. The blades are moved together by means of sprocket wheels and chains and a single operating handle which can be placed at any convenient point near the switch itself or close to the ground. The handle can be locked in the closed or open position.



OUTDOOR DISCONNECTING SWITCH.

The entire operating mechanism, including the sprocket and chains, is protected from the weather. The contacts are installed in housings and the switch cannot therefore be rendered inoperative by rain or snow.

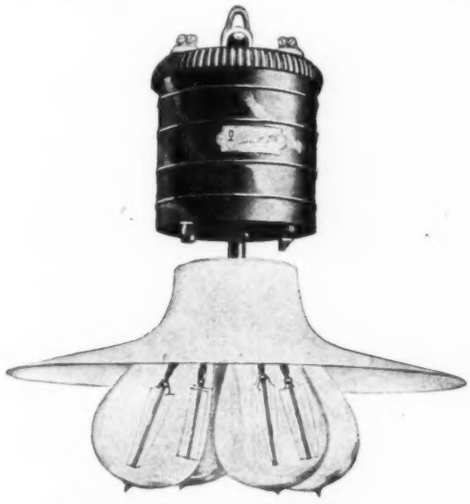
The blades are so shaped that it is difficult for ice to form on them, but if this should happen, small wheels, which rest on the upper edge of the

switch blades, serve to break this ice when the switch is opened, and thus keep it from getting into and clogging the mechanism of the switch.

The switch contacts are protected by goat horns so that, in the event of opening magnetizing currents or larger currents accidentally, the contacts will be protected.

A New Cluster Protector.

The simplest application of low-voltage tungsten-filament lamps is to operate them in series, thus obviating the necessity and expense of transformers. One drawback to the operation of lamps in series, however, is the fact that when one lamp burns out in a series all other lamps are cut out and remain so until the burned-out lamp is replaced by a new one.



NEW CLUSTER PROTECTOR.

The accompanying illustration shows the Warner lamp protector which makes it possible to burn lamps in series without this drawback.

The Warner protector is contained in a weather-proof case, and is arranged so that it may be applied to any cluster. The protector mechanism comprises an absolute cut-out for each of the four lamps in the cluster, and should a lamp burn out it switches into the circuit an amount of resistance precisely equal to the burned-out lamp, so that the remaining lamps in the series are permitted to continue burning without the slightest interruption.

This device, which is being manufactured and placed on the market by the Warner Arc Lamp Company, Wilton Junction, Ia., will take care of four lamps of any size from ten to 250 watts.

The New Arrow Socket.

Simplicity, convenience and economy are the principal characteristics of the new Arrow socket shown in the accompanying illustration, which is being placed on the market by the Arrow Electric Company, Hartford, Conn.

As may be seen from the illustration the socket may be easily taken apart and put together with a snap motion. In producing this socket the manufacturer has developed a new method of connecting the shell of the socket to the cap. The socket connection consists of four indentations on opposite sides of the upper edge of the shell, which engage with notches on the interior of the cap. Two of these indentations are designed to fit into slots in the rim of the cap to prevent the socket and shell from being pulled apart by a straight tension of the socket interior. The other indentations are designed to prevent the shell and cap turning relatively to each other. These two indentations engage with the metal pieces between slots in the rim of the cap. The edge of the cap is turned over the rim in which slots are provided to hold the rim in position. The rim is prevented from turning in the cap by bosses projecting in the slots at the upper edge of the rim.

NEW ARROW SOCKET.

In testing the efficiency of this socket it was found that it withstood a straight tension of thirty pounds without pulling the shell and cap apart.

Exports of copper, for the week ended December 8, were 5,541 tons; since the first of the month, 6,408 tons; last year, 9,186 tons.

The Cedar Pole Industry.

It is interesting to trace the development of the cedar pole from its primitive state in the forests to its application as an important factor in the electrical transmission systems of various kinds. Large camps comprising many men are established in different cedar tracts throughout the forests of the country. The trees are cut and manufactured into various lengths and sizes. The bark is taken off in the woods or where the stock is banked. The butts and tops are sawed off, and all knots on surfaces are trimmed smooth.

From the forests this timber is transported to concentrating yards, which are usually situated convenient to transportation facilities. In the concentrating yards the poles are sorted according to size, and are ready for shipment.

In one of the large concentrating yards of the W. C. Sterling & Son Company, Monroe, Mich., located at Bay City, over 120,000 poles are stored and seasoned. Government experiments show that cedar seasoned for a year or more will last a much longer time than freshly cut cedar which has not had a chance to thoroughly dry.

Some interesting statistics gathered by this firm are given herewith. A circular published states that in 1907 there were more than 800,000 miles of pole line in operation in the United States. The average line contains forty poles to the mile, so there were approximately 32,000,000 in use. Assuming the average life of a pole to be twelve years, to maintain the lines now in use requires 2,650,000 poles yearly. A government report states further that seasoned timber in contact with the ground will outlast unseasoned timber.

Equipment for the Galveston-Houston Line.

The General Electric Company is building for the Galveston-Houston Electric Railway Company (Stone & Webster, constructing engineers), four switchboards complete with the entire equipment, including meters, instruments, electrolytic lightning arresters, disconnecting switches and oil switches.

One board of ten panels will go in the main station and one of six panels in substation No. 2, which is located in the main station. In substations No. 1 and No. 3, which are each

fourteen miles distant from the main station, there will be a switchboard of six panels.

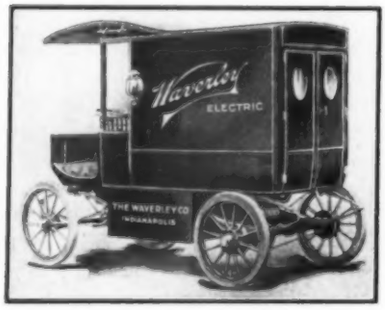
The power will be generated at 2,300 volts, transmitted at 33,000 volts, and used in railway work at 600 volts after going through rotaries in the substations.

Electric Delivery Wagon with Shaft Drive.

The Waverley model 33 electric wagon with shaft drive promises to revolutionize the delivery business of department stores, dry goods stores, milliners, grocers, laundries, and all that class of dealers which has many quick deliveries to make every day in the week and every week in the year, according to the manufacturers.

The speed, lightness, handiness, and dependability of this electric make delivering the goods the simplest and easiest of all of the complex problems of merchandising.

Either solid or pneumatic tires may be used on this car. There is sufficient battery power and motor energy to carry the loaded wagon at a speed of ten, twelve or fifteen miles an hour for a distance of from 50 to 75 miles on one charge.



ELECTRIC DELIVERY WAGON.

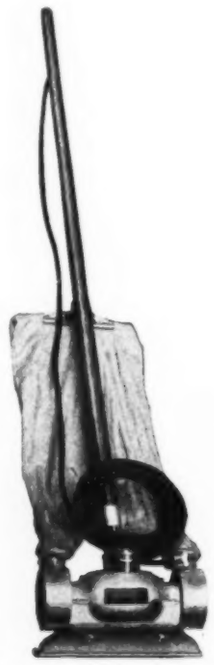
The capacity of the car is sufficient for any class of merchandise that in shipping to another city would ordinarily go by express, and this car compared with other delivery wagons and trucks is as express compared with freight.

The size of the car permits of its being run into the shipping room of any store, kept there when not in use, or charged there if a proper charging apparatus is installed. The absence of mechanical difficulties or complexities permits its being operated by any one that can be trusted to deliver goods properly.

Electric Suction Sweeper.

Electric suction sweepers are steadily gaining favor in this sanitary age, due to the fact that people are realizing the seriousness of infection from dust. In the accompanying illustration is shown a new model suction sweeper, being placed on the market by the B. B. Downs Company, St. Paul, Minn., which is of simple and durable construction, and embodies many commendable features.

The air-cooled motor with which it is equipped rests in a horizontal position, with oil holes directly over the bearings. The motor and bearings are inclosed in an inner motor casing, preventing any dust collecting on them. The cold air passing from the nozzle to the dust bag passes over the inner motor casing, keeping the motor cool at all times. Two exhaust fans, one on each side of the machine, gives constant, powerful suction.



ELECTRIC SUCTION SWEEPER.

The Downs suction sweeper weighs but ten pounds and may be operated on either direct or alternating-current circuits. It is equipped with a double dust bag, which prevents leakage of dust.

Trade With the Philippines.

During the operation of the present tariff law, giving free trade with the Philippine Islands, trade in general has about doubled with this country. The imports and exports of electrical appliances for the ten months ending October, 1910, amounted to $155,501, while for the same period in 1908 they were only $86,182.

Mill Clusters.

In the accompanying illustration is shown a new fixture, being placed on the market by the Benjamin Electric Manufacturing Company, Chicago, which is particularly adapted for lighting installations in mills, factories, etc.

The fixture shown herewith has a twenty-four-inch enameled-steel concentrating-dome reflector, and is intended for use where it is necessary to hang the lighting units sufficiently high to clear traveling cranes.

The Benjamin Company is also placing on the market a fixture of similar design adapted for use where the lighting units are to be suspended from 25 to 30 feet above the floor. This latter fixture is provided with a twenty-four-inch flat-cone distributing reflector.

It is apparent that the design of the reflectors of these fixtures is such that a maximum amount of light is reflected to the required planes. It is claimed by the manufacturers that the reflected light volume of these units is 1,500 candlepower.

BENJAMIN MILL CLUSTER.

Both types of fixtures are equipped with large base sockets for 250-watt lamps, an eight-inch stem of one-half inch iron pipe and weather-proof shock absorbers. They are regularly furnished wired in series for 220-volt circuits.

Experiments with an electric plow are being made in the suburbs of Mexico City, Mex., and if satisfactory the plows may later be installed on some of the large haciendas. The plow with which the trials are being made will do the work of about twenty ordinary two-horse plows.

The New Morrison Storage Battery.

For some time it has been the consensus of opinion among storage-battery experts that the common storage battery using lead and lead-peroxide plates has reached a stage of development where not much further improvement may be expected in making it yield a larger output per unit weight. They have therefore turned their attention to other reversible chemical reactions involving materials of relatively low weight. The Edison storage battery is the outcome of this search for materials suitable for a light-weight cell. Among other inventors in this field is William Morrison, of Des Moines, Iowa, who is well known for his storage-battery inventions dating back nearly a score of years, and who a few weeks ago was granted a number of patents on his recently perfected alkaline accumulator.

As the result of extended chemical researches, Mr. Morrison has found a combination of active materials which he regards as the optimum of light-weight cell construction and as fully

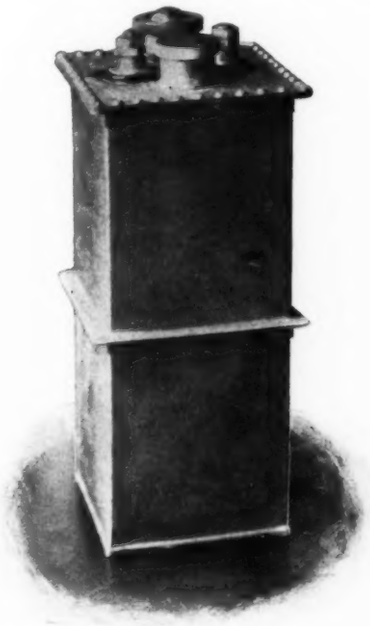


FIG. 1.—VIEW OF MORRISON STORAGE BATTERY COMPLETE.

meeting the severe requirements of vehicle batteries. The preferred active material for the positive plates is an oxidized amalgam of copper, that of the negative plates is chiefly zinc chromite. The electrolyte is potassium hydrate, in which neither of these active materials is soluble. The preparation of the active materials is somewhat complicated, as also is the series of chemical changes that take place during charge and discharge.

The accompanying diagrams taken from among the numerous patent drawings show the main features of

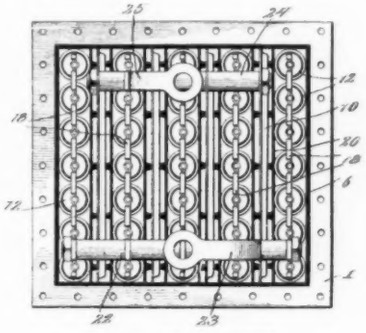


FIG. 3.—PLAN VIEW.

the cell construction. The cell complete is shown in Fig. 1, which is from a photograph of a cell recently exhibited and tested by Mr. Morrison in Chicago. Fig. 2 shows a section of the cell with portions of the plates and separators broken away to reveal the general arrangement. Fig. 3 is a plan of the cell showing the assembly and connection of the plates. The containing jar is of thin sheet steel or other suitable metal and is very strong and light. Through the cover extend the bolted terminals *3*; here is also located a filling cap and a gas vent which prevents the electrolyte from splashing out. The interior of the casing is insulated from the plates by an insulating lining *6*.

Each of the positive plates *10* consists of a pair of thin copper sheets provided with square window-like openings stamped out by cutting the sheet on three sides of each opening and bending the fourth side inwards at right angles. The positive active material is piled between the two sheets or grids of copper and the latter brought together by great pressure, thus securely locking the little projections through the active material into the opposite openings and forming a rigid box-plate construction.

The negative plates *12* consist each of a group of tubular columns made by covering lava tubes with asbestos, then with a layer of the active material and finally with a steel envelope. The details of the manufacture of both the positive and negative plates are somewhat intricate, but they have been perfected so that the entire construction work is done by special machinery.

By means of a strip *18* the terminals of the negative tubes are connected together to form a plate of any desired number of parallel tubes. These plates are connected together by a strap to form the negative group. The positive plates are similarly connected to form a group. As shown in Fig. 3, the positive and negative plates are alternated as in other storage batteries and they are separated from each other by perforated and ribbed rubber or other separators.

Mr. Morrison furnishes the following data concerning the cell shown in **Fig. 1**: Over-all dimensions—height, 16 inches; body of case, 5.25 inches square; outside of flanges, 6 inches square; total weight of cell complete, 36 pounds; capacity at normal discharge rate, 690 ampere-hours; average discharge voltage, 1.3 volts. These figures show the remarkable output of 19.4 ampere-hours per pound of cell and the total capacity of nearly 900

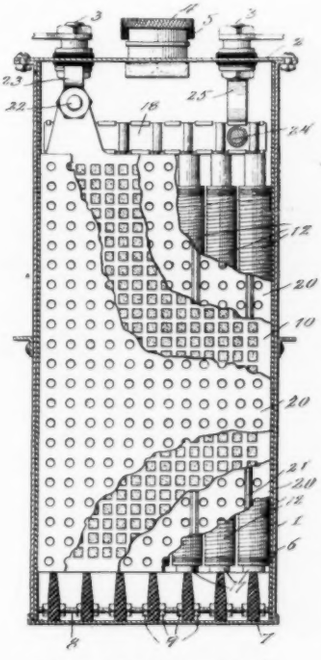


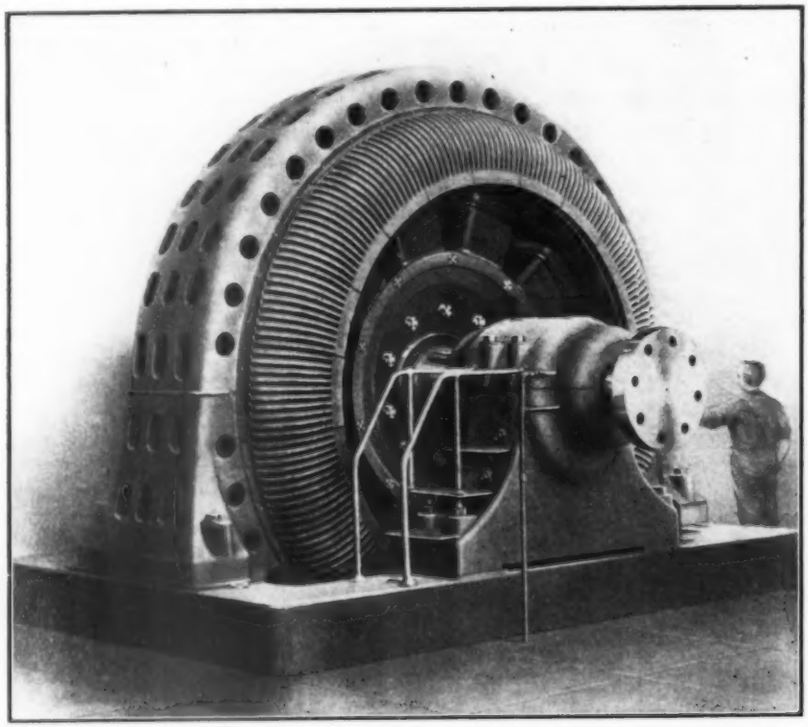
FIG. 2.—PARTIAL SECTION.

watt-hours. Aside from its light weight for this large capacity, the inventor states that the cell has been tried out under the most severe service conditions, frequently short-circuited, discharged to zero, left standing without charge, and has yet failed to show any inherent defects.

Large Water-Wheel Alternators.

The Cliff Electrical Distributing Company of Niagara Falls has just placed an order with Allis-Chalmers Company for another 6,500-kilowatt 12,000-volt, three-phase, twenty-five-cycle alternator. This makes the sixth of these large machines to be installed in this powerhouse.

These alternators have been of particular interest to the engineering profession because of the unusual and peculiar features of their design and construction made necessary by the conditions of operation. On account of the possibility, which is often present in hydraulic-turbine installations, of the turbine running at excessive speed, it was necessary to construct the alternators so that they would be safe under runaway conditions.



6,500-KILOWATT WATER WHEEL.

The normal speed of these machines is 300 revolutions per minute, but they are designed with an over-speed safety factor of seventy-five per cent which enables them to run safely at 525 revolutions per minute, which is about five times as great as that of machines of the same capacity when driven by steam engines.

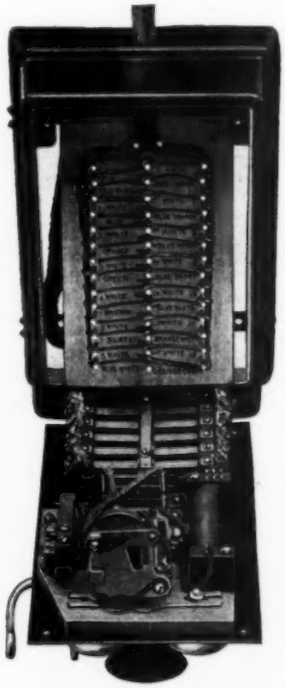
The value of taking these precautions and the success which attended these machines was recently very forcibly illustrated. During adjustments to one of the turbine gates an accident happened which threw the governor out of operation and allowed the unit to run away. Although the maximum possible speed of 525 revolutions per minute was attained, neither the generator or the turbine suffered accident.

A Cable Forming Board.

In order to make it easier for the electrical contractor who has never had any experience whatever with installing intercommunicating telephones, to install their interphones in an up-to-date manner, the Western Electric Company is furnishing full-sized diagrams of cable forming boards. These diagrams enable the contractor to make cable forming boards for every variety of interphone sets.

The advantage of forming the cable is apparent to all those experienced in telephone work, but until recently its importance was not realized by the electrical contractor. Experience has shown that the very best plan to follow in cabling an interior telephone system is to form the cable at each telephone set so that each conductor or pair of conductors will be separated from the rest and sewed permanently into their respective places by the means of extra stout twine made especially for the purpose. In this way every conductor is brought out of the cable at its proper place and there can be no disarrangement of the conductors due to later handling. This reduces the likelihood of the conductors being crossed to a minimum.

One of these diagrams, as furnished by the Company, is first glued upon a board about one-half an inch thick and then the board is sawed along the edges of the diagram. This makes the board of the proper size for the different types of telephones noted on the diagram. At specified points, small nails are driven into the board and the wires are formed around the nails and sewed into place as indicated in the illustration.



A COMPLETELY FORMED CABLE.
Cable entering top of set has been formed and board is ready to be removed.

A completely formed cable, sewed as it should be, is shown herewith. The proper twine used for the purpose is twelve strand linen, as this provides sufficient strength for allowing the stitches to be drawn up extremely tight without the chance of breaking the twine. When the cable is completed, it is lifted off the forming board and is then of the proper size, so that the conductors come out of the proper places to attach directly to the correct terminals in the telephone sets.

Current Electrical News

GREAT BRITAIN.

(Special Correspondence.)

LONDON, DECEMBER 2.—The somewhat remarkable libel action which has been in progress during the past three weeks, concerning the experiment by the London County Council with the G. B. surface-contact system, came to a close yesterday, a verdict being given for the patentees with $60,000 damages. Briefly, the point of the libel action was this: In 1907 the Council entered into an agreement with the owners of the G. B. system to install it in the Mile End Road on the basis of a royalty of $2,500 per mile if the experiment proved successful. According to the officers of the Council this $2,500 included technical advice and assistance on the part of the inventors, but the latter contended that it did not. Consequently the tramways department was left largely to its own devices in installing the system, and trouble inevitably followed. The present decision is being appealed against.

After all the argument since July concerning the promotion of a bill by municipalities owning electricity works empowering them to wire premises for electric lighting, heating, etc., there is every probability that one wil not be framed. In the first place it would be impossible for one council to promote a bill to confer powers upon all other councils; secondly, the spending of money for this purpose by those municipalities not directly concerned would almost certainly be held to be illegal, and yet again, as the corporations are not absolutely unanimous, the Municipal Electrical Association—to which practically every municipality subscribes—could hardly undertake the task. It would seem, therefore, that a bill by the Board of Trade is the only alternative. It is clear that the matter is being regarded as of some importance by those outside the immediate claims of the controversy, for a public discussion of the question upon an impartial platform takes place in London next week.

What is said to be the largest clock in the world is now in course of completion at Leicester. The clock in question is intended for the tower of a Liverpool insurance company's offices. Each of the four dials measures twenty-five feet and the minute hands measure fourteen feet long by three feet at the greatest width. The system of operation involves the use of a separate reciprocating slow-speed motor for rotating the hands, the time-keeping mechanism being distinct and having the movement under control every half minute. The dials will be electrically lighted.

Those responsible for the maintenance of London streets have frequently encountered troubles due to explosions in electric light and telephone boxes from the accumulation of gas. In the case of the former, certain regulations are imposed in order to insure proper ventilation, but hitherto no such arrangements have been made for the Postoffice and National Telephone Company's street boxes. Efforts are now being made in this direction.

The death has just occurred of Gustav Byng, chairman of the English General Electric Company. Mr. Byng, owing to bad health, has not been much before the electrical public of late years. He came from Germany to England when only eighteen years old and before 1880 commenced in the business which now finds occupation for some 8,000 workers.

The feature of the notices relating to electrical bills in Parliament next session is the number of applications for powers to adopt the trolley omnibus system of electric traction.

In a discussion on street lighting at the Institution of Electrical Engineers last week, the suggestion was made that a standard specification for street illumination should be drawn up. Some members, however, saw a difficulty in electrical engineers proceeding alone in the matter, and thought it would be necessary to bring the gas engineers and architects into the consultation. It is clear that street lighting authorities will have to be urged to improve their standard of lighting in view of the changed conditions of street traffic. In many parts the standard is very little higher than it was in those days when mechanical traction was unknown.

An important patent infringement action commences on Monday, in which the Marconi Company is proceeding against the owners of the Balsillie system. G.

CONTINENTAL EUROPE.

(Special Correspondence.)

PARIS, DECEMBER 1.—Electric-furnaces for steel are used increasingly in Sweden and Norway. Near the hydraulic plant on the Trallhättan fall there is being built a 2,500-horsepower furnace of Grönwall type. A prominent syndicate, the union of different iron interests, has devoted the sum of 250,000 crowns in order to make tests upon Swedish ores in this furnace so as to obtain various data for steel production. The question is of special interest in this country, owing to the abundance of water power. M. Lundberg, a prominent official of the Swedish Copper Company, has already built a 4,000-horsepower steel furnace of the same type, and expects to begin operating it soon. In Norway there is being erected a 4,000-horsepower electric-furnace plant for iron and steel, and it will be set running in about six months.

There is some talk of having an exposition at Paris about 1920, but the matter is far from being decided. A move was made in this direction, however, by the Senate Commerce and Industry Committee, and it made a favorable report on the subject. The next step is to bring the matter before the Minister of Commerce.

In Austria there will be erected the Afinger hydraulic plant for supplying current to a new electric railroad which is to be built in South Tyrol and known as the Talfer Railroad. The hydraulic plant will contain three turbine groups of 11,000-horsepower and one of 3,000-horsepower. It is also planned to build a plant lower down at Ravenstein which will have two groups of 8,000-horsepower and one of 2,500-horsepower.

At Madrid has been formed the Maria Luisa Hydroelectric Company, for the purpose of erecting a turbine plant of some size. It will operate a power network in order to cover the region including the towns of Valenzuela, Calatrava and others.

Wireless telegraphy to submarines is to be tried in France at the port of Cherbourg. Two of the submarines, the *Prarial* and *Berthelot* are equipped with apparatus, and have long masts which will always project out of water. Messages will be sent from the shore or from the vessels of the fleet.

In Russia the municipality of Simferopol has awarded the franchise for electric lighting of the town and also for an electric tramway. I also note that an electric railroad is planned between Moscow and Obiraloff, taking in other towns in the region.

The administration of the state railroads of Germany has lately decided to use electric traction on the Laubau-Königszelt and the Dessau-Bitterfeld lines. A thirty-mile electric railroad is to be constructed between the towns of Wesel and Emmerich, according to the present project. It is stated that definite measures have been taken as regards the new subway line for Berlin which runs across town from north to south, and that the plans presented by the Allgemeine Electricitäts Gesellschaft have been accepted. The probable cost of the work is $22,000,000.

Attention is being given to improved methods of train lighting on the Belgian railroad lines near Antwerp, and a concourse will be opened for such apparatus for use upon passenger cars. The tramway system of Ghent is to be increased by a new line. It is to connect the South railroad depot with the St. Pierre depot. The railroad company is also planning to build other lines before long. An electric plant is to be erected in the town of Deventer, Holland, and the Municipal Council has allowed a subsidy for its construction.

Electric locomotives for the new Lötschberg line in Switzerland are now being constructed by two of the leading electrical firms. One of each will be used in order to establish various data in order to serve as a basis for laying out the whole system. Trials of the new locomotives will be made upon the part of the railroad line extending from Spiez, on the southern shore of Lake Thun, to Frutigen, and the Bernese Alps Railroad Company is now taking measures to equip this section so that it will be ready to operate with the electric locomotives before long. A. DE C.

CANADA.

(Special Correspondence.)

OTTAWA, ONT., DECEMBER 10.—Preliminary figures of the Light, Heat & Power Company, of Kingston, Ont., show a surplus of revenue over expenditure, in connection with plant on this year's business, of $12,000.

The London Electric Company, of London, Ont., has announced its intention of cutting rates to meet any reduction made by the Hydro-Electric Commission. The Company has refused the offer of the City to purchase the Company's plant for the sum of $100,000.

It is stated that the Shawinigan Water & Power Company is about to issue $500,000 of new common stock, and that instead of it going to shareholders, it will be all taken up by the interests connected with the Montreal Light, Heat & Power Company. When this transaction is consummated, it will unite the destinies of the two concerns more closely than ever.

It is expected that the water will be turned into the flumes of the Sherbrooke Power & Railway Company's plant on December 21. Only small matters have to be adjusted. The wheels and switchboards are in place, and the Company will be generating

power in its own plant by the first of the New Year. The transmission line to Capelton is about completed, so that there will be no delay when the word is given to turn on the power.

Final steps towards the construction of an electric railway between Niagara Falls, Welland and Dunnville are now being taken. The officials and directors of the proposed road, at a meeting recently held in Welland, Ont., decided to go ahead with the construction as soon as possible. A provincial charter has been secured and franchises from the towns, townships and cities, through which the road will pass, will now be sought for, and when these are secured, the construction work will at once be started. It is expected that the line will be in operation by the middle of next summer.

Speaking to the County Council of Middlesex, Ont., Hon. Adam Beck, the minister of power for Ontario, announced a government plan for supplying electric power to farmers. Low-tension wires are to be erected to radiate thirty miles from power centers. As a group consisting of at least twenty farmers can now go to the council of the county, and have a telephone line erected, paying for it on the same basis as is done in the case of local improvement, so will the Ontario Government now foster and promote power lines. In a sense, the Government will be but the financial agents of the farmers. The Government will erect low-tension lines, said the minister, which the farmers will pay for at the rate of four per cent on the investment, retiring the indebtedness at the end of fifteen or twenty years, in the same manner as in retiring debentures. W.

COMMISSION NEWS FROM NEW JERSEY.

(Special Correspondence.)

In the complaint made by the Acacia Lodge No. 20, of Dover, N. J., against the Dover Electric Light Company, the questions were raised as to whether a minimum charge was legal and as to whether this minimum charge could be based on candlepower. Both questions were answered in the affirmative by the Board. Two questions, however, remained for consideration, these being, (1) in regard to the extent to which the right to make this minimum charge is affected by the Company's agreement with the City, and (2) whether the charge is reasonable in amount.

The Board, in the matter of the application of the Wildwood & Delaware Bay Short Line Railroad Company, approved the issuance, sale and delivery of $500,000 capital stock and $562,500 bonds for extensions and construction work.

The Board recently received an inquiry from the City Clerk of Ventnor City asking whether, under the public utilities act, a telephone company seeking a franchise is restricted from furnishing free telephone service at public buildings, such as fire house, city hall, police department and public schools. The act recites that no public-utility company shall give, grant or bestow upon any local, municipal or county official any discrimination, gratuity or free service whatsoever. The Board requested an opinion from the Attorney General as to whether furnishing free telephone service at public buildings would conflict with this provision of the law. The Attorney General has advised the Board that: "The language of the statute quoted has regard merely to such discrimination, gratuity or free service as may be granted, or bestowed upon the class of officials described by its terms. The discrimination and gratuity forbidden is purely personal in its scope. In my opinion this provision of the act would not prevent the granting of a franchise to a telephone company by a municipality when, by the terms of the franchise, free service was to be furnished the firehouse, city hall and other public departments within the confines of the municipality. Such free service might well be one of the moving considerations in the granting of the franchise, and does not, in my opinion, fall within the evil which the statute just quoted sought to eliminate."

COMMISSION NEWS FROM NEW YORK.

(Special Correspondence.)

The application of the North Shore Electric Light & Power Company for a rehearing on its application for permission to exercise franchises received from the towns of Brookhaven and Smithtown, Suffolk County, were heard early this week. The original application of the Company was denied because of an existing company at Port Jefferson. The North Shore Company now claims that the existing company has not kept faith with the Commission in rehabilitating its plant and improving its service so that the public is properly served, and asks that the new company be allowed to enter the field at Port Jefferson.

The application of the receivers of the Hudson River Electric Company for permission to operate under a franchise granted for public lighting in the village of South Glens Falls was also heard. The application was vigorously resisted by companies now existing at South Glens Falls. The application of the Port Jefferson Electric Light Company for authority to issue $30,000 in bonds was also heard.

An adjourned hearing was held upon the complaint of the Board of Aldermen and various civic organizations, in the various boroughs, against the New York Telephone Company as to the ten-cent toll rate charged between different boroughs of the city.

The Commission has heard the application of the Hoosack River Electric Light & Power Company for authority to exercise franchises granted to it in the town of Pittstown, Rensselaer County, for the furnishing of electric lighting to the unincorporated village of Johnsonville, and for permission to issue $2,000 in additional capital stock. The Commission reserved its decision.

COMMISSION NEWS FROM WISCONSIN.

(Special Correspondence.)

The Commission has handed down its decision in the case of Harrington et al vs. The Milwaukee Electric Railway and Light Company. This case involved the reasonableness of electric power rates for charging electric automobiles. The petitioner declared that the rates charged by the Company, which consisted of a minimum charge of $5.00 per month and a current charge of eight cents for the first 100 kilowatt-hours; six cents for the second 100 kilowatt-hours; five cents for the third 100 kilowatt-hours; four cents for the next 300 kilowatt-hours; and three cents for all current consumed over and above 600 kilowatt-hours; were excessive and unreasonable. It appeared that the petitioner had a mercury rectifier of about six-kilowatt capacity used in transforming alternating current to direct current for charging an automobile of about two and one-half horsepower capacity, and that the company had based its minimum bill on the rectifier capacity. It also appeared that current was used but sparingly by the petitioner in the winter months. The Commission called attention to the fact that the charging of automobiles is a service usually furnished when the demand on the central station is light; that many companies have accorded this load special rates; that this special rate consideration is sound and in keeping with the principles of cost of service extensively commented upon by the Commission in previous decisions. The Commission noted that subsequent to the filing of this complaint the company had filed certain optional rates designed to give concessions to off-peak users. These optional rates were described as "off peak" and "ten to seven" schedules. The Commission held that in view of the cost analysis made of the operating expenses of the Company, and in view of the optional rates now in force, and in view of the situation as a whole it did not feel justified in ordering any changes in the rates complained of at this time and the petition was dismissed.

The Greenwood Municipal Electric Lighting Plant petitioned the Commission to be allowed to put into effect a minimum bill of forty cents per month per consumer in addition to its present schedule of rates. The Commission granted the petition and called attention to the fact that there are certain expenses incurred by an electric utility which may be called "consumer" expenses and are incurred because of the utilities' readiness to furnish current to the consumer, irrespective of whether or not he actually uses current every month. A table was prepared showing the average consumer expenses of all the electric companies in the state in cities of less than 10,000 population.

ITEMS.	EXPENSE PER METER PER YEAR.
Maintenance of meters	$ .50
Customers' premises expenses	.34
Collection expenses	.73
Interest on meters and services at 7 per cent on $14	.98
Depreciation on meters and services at 7 per cent on $14	.98
Total	$3.53

The above table and an analysis of the Company's operating expenses showed that the consumer expenses would amount to about thirty-two cents per month in this particular case. Adding to this figure the average value of the current used by the smallest consumers who would be affected by the minimum made it evident that a forty-cent minimum would not be excessive or unreasonable.

INTERSTATE COMMERCE COMMISSION NEWS.

(Special Correspondence.)

Just what will be the outcome of the hearing recently held by the Interstate Commerce Commission in the matter of the application of the act to regulate commerce as amended, in so far as it relates to the regulation of telegraph and telephone companies is yet to be learned. At the hearing held last week the following subjects were discussed: (1) What telegraph and telephone companies are subject to the act to regulate commerce? (2) May telegraph and telephone companies subject to the act issue franks entitling to free interstate service, or may they grant free interstate service, and if so, to what extent? (3) Are telegraph and telephone companies subject to the act required to file their tariffs of charges under the sixth section? (4) Do Sections 2 and 3 of the act, forbidding rebates and undue preference, apply to telegraph and telephone companies?

Under the provisions of the first question it was suggested that the following questions might arise, taking the following statements as a basis of thought; namely, that by a state company is meant one whose lines are located entirely within one state; and by an interstate company, one whose lines extend from a point in one state to a point in another. This being granted, then the following questions arise: First, if a state company receives a message at a point within the state, for transmission to a point without the state, which it transmits over its lines to another point within the state, and there delivers to an interstate company for transmission to destination, is the state company, by virtue

of its participation in this transaction, made subject to the act? And, secondly, take the case where a state company and an interstate company have switchboard connection. If the two lines are connected so that a person within a state talks with a person at a point without the state, or so that a message is transmitted directly from a point within the state to a point without the state, does that amount to interstate commerce which brings the interstate company within the scope of the act?

The session of the Commission, as was distinctly stated in the call, was not held for the purpose of determining the status of any particular company, but was for the purpose of having a friendly discussion of the many points involved. Among those present at the meeting were D. J. Cable, for the telephone associations; R. H. Overbaugh, for the Postal Telegraph and Cable Company; Hunt Chipley, of New York, representing the American Telegraph and Telephone Company; Rush Taggart, of the Western Union; S. H. Moore, of the Bell Telephone Company, of Pennsylvania; Frank H. Wood, National Independent Telephone Association; W. D. McLain, United Wireless; John Bottomley, vice-president of the Marconi System; J. C. Jones, of the Keystone Telegraph and Telephone Company of Philadelphia; H. Lee Sellers, of the Telepost Company; H. L. Reber, of the Kinlock Telephone System; F. B. Travis, representing the French Cable Company and the United States and Hayti Telegraph Cable Company, and N. Koenigsberg, for the National News Association.

Opinions expressed indicated that it was the evident intention of Congress to subject these companies to the operation of the act; but a determined effort was made by the representatives of the Bell Telephone Company and the Western Union Telegraph Company to prove that those companies were outside of the purview of the sixth section relating to the filing of tariff rates by the companies.

As to the giving of franks and passes, the telegraph companies argued that they were in the same position as the railroads, and that the exchange of such courtesies were only to be extended to the employees of the companies.

The first speaker was Rush Taggart, who stated that in his opinion Section 1 of the act applied to all telephone and telegraph companies.

It was his contention that the intent of Congress as to free transportation and the issuance of franks shows that the telegraph and telephone companies should be brought within the powers of the limitation of the act, for, as we read it, it shows there was an intention on the part of Congress to include franks and passes and issue regulations for their use, such now appears in the case of the railroads. The intent of Congress was evidently to prevent free service except for an interchange of such courtesies between common carriers and the certain classes specified in Section 1.

In so far as the term "transportation" is concerned, he took the position that the telegraph and telephone companies are not common carriers.

Commissioner Clark said that, according to the contentions presented by Mr. Taggart, rates could be changed without notice, and that a man could be charged a certain price for a certain service on one occasion, and then, on a moment's notice, the rates could be changed, and a new charge could be made to another man for the same service, and that the rates could be juggled with to suit the companies, without any restraint whatever.

Commissioner Prouty took the position that if the companies are exempt from the provisions of Section 6 of the act, then they would be exempt from all suspensions of rates, and that he could not see how the companies could avoid the application of Section 6, if the other sections of the act are applicable.

Hunt Chipley took the position that it would be impossible to publish lists of the rates charged by the company at every one of its stations. A station is a telephone located on a man's desk or in his home. At present there are 5,000,000 such stations; and that there are 1,429,000 different rates; in addition to this there are 53,460 telephone tolls, 2,477,812 block stations, and in each block is contained about 500 square miles of territory and 13,707,898 section rates.

N. Koenigsberg, representing the National News Association, asked that there should be the broadest possible application of the law in so far as it was made applicable to the telephone and telegraph companies. He said that his association alone was spending not less than a quarter of a million dollars a year for the use of the wires of these companies.

While he did not want to appear as making any complaint, he stated that it appeared to be very desirable the law should be enforced, in the matter of giving preferential rates, as it is undoubtedly a fact that preferential rates have been given and that rebates have been granted to large users of the wires. He also suggested that the Commission might make it possible for the large users to have access to the rates of the wire companies and so make the contracts with all large users accessible.

D. J. Cable spoke in the interest of the Ohio Telephone Association, taking the position that messages originating at minor stations may be transmitted beyond the confines of a state under toll contracts, in which case the minor company simply becomes a leased wire for the time being. It would, therefore, be an injustice to compel the lesser companies to file schedules of their rates.

LIGHTING AND POWER.

(Special Correspondence.)

MORRISONVILLE, ILL.—The Morrisonville Electric Company has certified to an increase in capital stock, raising the amount from $6,000 to $15,000. Z.

STREATOR, ILL.—The City Council has named a committee to investigate the possibilities of the decorative street lighting systems. Z.

TOLEDO, O.—E. P. and A. R. Badger have been granted an electric light franchise by the Toledo City Council, and the Council has contracted for street lighting for ten years.

MENDHAM, N. J.—Following the agitation regarding franchises it has been announced that the city is to be illuminated by electricity. Power will be furnished by the Bernards Water Company.

TAYLORVILLE, ILL.—The Taylorville Retail Merchants Association has offered to install sixteen ornamental lamp standards with tungsten clusters about the city square if the City will supply current. Z.

BEAVER DAM, WIS.—The Horicon Light and Power Company of Beaver Dam was incorporated with a capital of $10,000. The Company is formed for the purpose of establishing an electric light plant at Horicon.

HARTFORD CITY, IND.—Plans are being made for the erection of a new stone and brick structure for the Hartford City Lighting Company. The Company proposes to equip the house with $35,000 worth of new machinery and apparatus. S.

DAHLONEGA, GA.—The Cedar Mountain Land Company will establish an electric lighting plant to furnish illumination for hotels, cottages, etc. H. R. Robertson, 727 Candler Building, Atlanta, Ga., is secretary and general manager of the Company. B.

VIRGINIA, MINN.—The school board has provided for the installation of an electric light plant in the high-school building here. Two gasoline engines driving seventy-five-kilowatt generators are to be put in the basement of the building.

BAYFIELD, WIS.—The Board of Water and Light Commissioners has completed plans for the building of a new and modern boiler house for the municipal water and light plant. The improvement, to be made next spring, will cost about $8,000.

ASHLAND, PA.—The work of installing the machinery in the newly erected power plant of the Locust Spring colliery at Locust Gap is under way. It is expected that the collieries between Locust Dale and Mt. Carmel will be operated by electricity by the first of the year.

CHARLTON, MASS.—Plans have been prepared for an electric generating plant to be installed at the Masonic Home at Overlook, Charlton. The plant will supply heat and also current for power and lighting. All machinery in the laundry is to be electrically driven.

BRAZIL, IND.—The City Council is considering a plan for the construction and equipment of a municipal electric light plant. The City owns and operates a water plant very successfully and this has prompted the city authorities to build a light plant for the city. G. C. Catterman is city engineer. S.

PRINCEVILLE, ILL.—The Elmwood Electric Light Company of Elmwood, Ill., of which E. L. Brown is general manager, and which will light the village, expects to have the improved service from the plant at Elmwood in operation by March 1. Improvements are to be made at the Elmwood plant. Z.

BLUFFTON, IND.—The City Council announces that it is in the market for the purchase of an engine for the municipal electric light plant. The capacity of the present engine in use is not sufficient for the load and the installation of a new unit has become a necessity. Other equipment will also be added. S.

COLUMBUS, KANS.—The Empire District Electric Company, which is a Henry L. Doherty Company operating in Joplin, Webb City, Cartersville, Mo., and Galena, Kans., has taken over the Columbus Electric Company of this city. The Empire Company will connect to the new plant at Riverton, Kans.

NEW MILFORD, CONN.—The improvements which have been in progress during the summer and fall on the plant of the New Milford Electric Lighting Company at Little Falls are now practically completed. Two 200-kilowatt alternating-current generators driven by water turbines have been installed.

CLEVELAND, O.—The Perry-Payne Company has taken out the permit for the construction of the big power plant on Oregon Avenue. It is estimated that $80,000 will be expended in the building, which is mushroom construction of concrete. The building will cover ground 135 by 87 feet and will be five stories in height.

LINTON, IND.—An injunction suit has been brought against the City Council to prevent the selling of the electric light plant belonging to the City. The City constructed the plant ten years ago and then leased it. The term of the lease expires March 1, 1911, and the City Council deems it advisable to sell the plant rather than expend a large sum for repairs and new machines. S.

CHARLOTTE, N. C.—The Southern Power Company has purchased the property and franchises of the Charlotte Consolidated Construction Company, embracing the local street car lines with

twenty-six miles of trackage, gas and electric lighting system. No price was given out, but it is said to be in the neighborhood of $1,000,000. The local plant which was purchased was capitalized at $1,475,000. B.

MEXICO CITY, MEX.—The Compania Irrigadora de Santa Maria, headed by Emilio Pardo, ex-minister to Belgium, as president, and Indalecio Sanchez Gavito, Jr., as secretary, will construct irrigation works on the River Apatlaco in the State of Morelos. It will also build a hydroelectric plant to furnish light and power to neighboring towns, and will construct a branch railway to the National lines.

EUGENE, ORE.—The Northwestern Corporation, which owns the Eugene gas plant and the electric plant at Springfield, which supplies Eugene with light and power, will soon begin the erection of a large brick building at Springfield to house the plant, which is now located in a flimsy wooden building. The new building will be 50 by 128 feet, three stories high, and the cost of the entire plant will be about $350,000.

KANSAS, ILL.—The village board accepted the proposition of the Central Illinois Public Service Company of Mattoon to purchase the lighting plant owned by the village. After improvements are made the plant will be operated independently until next year when it is planned to build an interurban railway line from Charleston, through Kansas, to Paris after which time the village will be lighted from the central plant. Z.

EL PASO, TEX.—The Electric Railway Company of El Paso has under consideration the construction of electric transmission lines from its power plant down the valley of the Rio Grande for the purpose of providing energy for the operation of irrigation pumping plants and various other industrial enterprises. The valley section is settling up rapidly with farmers who are installing irrigation systems for watering their land. D.

JOLIET, ILL.—The Illinois Valley Gas & Electric Company, a subsidiary of the Economy Light & Power Company, has purchased the plants of the Lacon Electric Company at Lacon and the Henry Light & Power Company of Henry. The Lacon plant in addition to supplying power for that village also supplies Sparland two miles away. As Henry is but nine miles from Lacon all three will be supplied from a plant at or near Lacon. Z.

SAN FRANCISCO, CAL.—H. M. Byllesby & Company of Chicago and New York, have entered the gas and electric light and power field of north and central California. They have filed articles of incorporation at San Francisco of the Western States Gas & Electric Company, with a capital of $15,000,000, of which $10,000,000 is preferred stock. The Company will immediately take over the Stockton Gas & Electric Company and the Richmond Electric Company in Contra Costa County.

WALLA WALLA, WASH.—The power line which the Pacific Power and Light Company plans to build into the Freewater country to tap 12,000 acres will probably be extended, and Manager W. B. Forshay says that there is every probability that it will tap 40,000 to 50,000 acres. Farmers of the Freewater section have signed for 200 horsepower and now those in the neighborhood of Vincent want it extended several miles, making the line about twelve miles long.

ALBANY, N. Y.—Plans have been approved for the new power house which is to supply light and heat to the capitol and state education buildings here. The boiler room will be of sufficient size to contain five engines and dynamos of 1,700-kilowatt capacity. At present only eight boilers and four engines and dynamos will be installed. The new building will cost about $500,000. Specifications as now drawn up require that work on the plant shall be finished by November 1, 1911.

SONORA, CAL.—The National Park Electric Company has filed a complaint in the Superior Court in Tuolumne County against the city and county of San Francisco, to restrain it from diverting 10,000 miner's inches of water immediately above the plaintiff's point of diversion near the Yosemite National Park boundary. The company claims a flow of 25,000 inches in Toulumne River and if San Francisco is allowed to divert her claim of 10,000, the plaintiffs will, it is claimed, be wholly deprived of their rights regarding the use of water. A.

JACKSON, GA.—The Central Georgia Power Company, of Macon, Ga., has just completed a $3,000,000 hydroelectric power plant across the Ocmulgee River, eight miles from Jackson. The dam is 100 feet high and 1,400 feet long, being built of concrete, and was completed after two years of work, during which time from 300 to 500 men were employed both night and day. The immense plant will generate a minimum of 18,500 and a maximum of 22,500 electric horsepower. The dam was built by Lane Brothers, of Altavista, Va. I.

TOLEDO, O.—An effort will be made to secure cheaper lighting in Toledo, within a short time. The price of electric lighting was fixed nearly five years ago, and the five year term will expire in January. Under the present contract the maximum rate fixed by council was nine cents per kilowatt hour, and this rate has been charged to all private consumers, except where consumption is light when a flat rate of $1.00 per month is charged. The County gets a rate of 3.75 cents per killowatt hour, and manufacturing concerns in many cases are charged as low as 3.50 cents. H.

ELECTRIC RAILWAYS.

(Special Correspondence.)

DONALDSONVILLE, LA.—The La Fourche Valley & Gulf Railroad Company will construct an electric line here.

DENVER, COLO.—The Del Norte & Pagosa Railway Company has been incorporated by Whitney Newton, James Q. Newton and Edmund F. Richardson. The capital is $50,000.

WEBSTER CITY, IOWA.—The Fort Dodge, Des Moines & Southern Interurban has taken possession of the Crooked Creek line running between this city and Lehigh. It was not expected to be transferred until January 1.

PHOENIX, ARIZ.—An interurban electric railway will be constructed between Phoenix and the suburb of Glendale by S. H. Mitchell and associates. The survey was finished recently and most of the right of way has been obtained. D.

WHITEWATER, WIS.—A franchise has been granted to the Badger Electric Railway & Lighting Company for an electric road through Heart Prairie, Elkhorn and Springfield to Geneva, construction on which will be started next summer. C.

AUGUSTA, GA.—The Augusta Railway & Electric Company, of which James U. Jackson is vice-president, is asking for a charter to extend its line of road to the city wharf on the Savannah River and it is locally reported that other extensions are in contemplation. B.

GREENVILLE, TEX.—S. A. Price and associates, who are constructing an electric street railway system here, have purchased a site for the proposed car barn which they will erect. It will be of brick. The new system will probably be placed in operation some time in January.

SPRINGFIELD, ILL.—Representatives of the stockholders of the Sangamon Valley Interurban Railway Company met at Hillsboro and decided to make plans for constructing the road between Hillsboro and Springfield. A short line is now operated between the court house and railroad depot in Hillsboro. Z.

GADSDEN, ALA.—Louis Hart, owner of the Bellevue Hotel, summer resort located on Lookout Mountain, for the past year engaged in effecting the organization of a company to build a railroad up the mountain, has stated in Gadsden that he has the capital stock, $50,000, subscribed and that the company would probably be formed within a few weeks. Mr. Hart expects to have his electric road in operation next summer. B.

TEXAS CITY, TEX.—The Texas City Traction Company has purchased 400 tons of fifty-two-pound rails for its proposed electric railway system here. Grading will soon be started. In addition to traversing the principal streets of the town the proposed system will run to the towns of Nadeau and La Marque and from the latter place to a connection with the Galveston-Houston interurban electric line. Fordyce Ridley of Galveston is promoter of the project.

SAN ANGELO, TEX.—The San Angelo National Bank has filed foreclosure proceedings against the San Angelo Street Railway Company and a date for the sale of the property will be fixed by the court. The electric railway system of the company is valued at about $85,000. Two groups of men contemplate bidding on the property when the sale is made. It is stated that whichever syndicate buys it will make important extensions and improvements.

PORTER, IND.—F. J. Meyer, representing the South Shore Electric Railway, has secured a franchise from the town board to build an electric line from Porter to the South Shore main line. Ever since Chesterton took up the electric lighting proposition it has had trouble, and this has developed into a war between the Geist interests and the South Shore people. Mr. Meyer and the South Shore wishes to prevent the Geist interests from building their proposed interurban line.

GALVESTON, TEX.—The rough plans for the proposed terminal station of the Galveston-Houston Interurban Railway Company at Galveston were recently finished and the drawings will be finished early in January. It is announced by M. M. Phinney, representative of the Stone-Webster intersts of Boston, Mass., which are constructing the railway, that the erection of the new terminal station here will be started soon after the plans are finished and approved. Nearly thirty miles of track of the new line are finished. D.

SPRINGFIELD, ILL.—Plans for the building of the line by the recently incorporated Springfield & Central Illinois Traction Company are detailed by President Isaac A. Smith. The main line, it is proposed, will run from Springfield, through Pawnee, Morrisonville, Hillsboro, Coffeen, Durley, Greenville, Carlyle, Hoffman and Centralia, a distance of 110 miles. A branch will run from Greenville to Old Ripley, Alhambra, Edwardsville, Granite City and to East St. Louis and St. Louis. Another will run from Coffeen to Vandalia, Kinmundy, Louisville, Sailor Springs and Olney to Mt. Carmel, the total line will be about 300 miles long, but it is not expected to complete at first more than the line from Springfield to Centralia and Greenville to East St Louis. Cost for the Springfield-Centralia lines is estimated at $2,350,000. Officers of the company are: President, Isaac N. Smith; vice-president George W. White; secretary, J. W. Gullett; and N. E. McMillan, treasurer. All the officers' with one exception, are of St. Louis. Z.

TELEPHONE AND TELEGRAPH.

(Special Correspondence.)

QUANAH, TEX.—The Southwestern Telephone Company will expend about $12,000 for improvements at this point. P.

NARDIN, OKLA.—The Peoples Mutual Telephone Company has been incorporated with a capital stock of $5,000. P.

INDIANAPOLIS, IND.—The Central Union Telephone Company is building two new exchange buildings and equipments in this city. S.

MARSHALLTOWN, IOWA.—The Merchants, Mechanics & Farmers' Telephone Company will install an automatic exchange at this point. C.

BLOOMING PRAIRIE, MINN.—The Blooming Prairie Farmers & Merchants Telephone Company has purchased the Steele County Telephone Company. P.

LANSING, MICH.—The London Hydro-Electric Company of Traverse City has filed articles of incorporation with the secretary of state. The company is incorporated at $50,000.

TERRE HAUTE, IND.—From a division point in this city the Big Four Railroad is operating 1,245 miles of its system by special telephone service and the service is most satisfactory.

HARRISBURG, IDAHO.—The Harrisburg Telephone Company has been incorporated with a capital of $10,000. The incorporators are Frank Finney, E. L. Gallagher, L. D. George and A. Bolander.

BAY MINETTE, ALA.—The Southern Bell Telephone & Telegraph Company, the main office of which is at Atlanta, Ga., will build a telephone line from Bay Minette to Fairhope, Ala., via Stapleton and Bromley.

LEMMON, S. D.—A farmers' co-operative telephone company is being organized for the purpose of building a line south from Heetinger, N. D., through Bison and other towns in that part of the state. Most of the towns affected are off the railroad.

APPLETON, WIS.—It has been announced that the headquarters of the Green Bay district of the Wisconsin Telephone Company will be changed from Green Bay to Appleton. A building to cost between $75,000 and $100,000 will be erected.

MARYSVILLE, O.—The Citizens' Telephone Company, of Delaware, has sold its Ostrander exchange to the Ostrander Telephone Company, which was operating a competing system. The exchange which the Citizens' Company has been operating at Warrensburg, is to be abolished.

MARION, ALA.—By the completion of a line extending sixteen miles southeast from Marion, another line has been added to Perry County's network of farmers' telephones. This line covers a fine stretch of farming property, crossing the Cahaba River at Fikes Ferry and extending along the river from Felix to Radford. I.

ELECTRICAL SECURITIES.

The President's message seemed to have very little in it which was of such a nature as to cause marked variation in prices. There was no new programme set forth and no unexpected situations developed. The principal item of interest, and the one thing which had the greatest effect on the market was the decision of the United States Circuit Court in the matter of the Temple Iron Company. The court sustained the contention that the Company is an illegal corporation, but absolves the roads from a charge of conspiracy and violation of the interstate commerce law. Stocks of the coal roads were buoyant after the receipt of the decision, Reading, Lehigh Valley and Erie showing very appreciable net advances for the week.

DIVIDENDS.

Butte Electric & Power Company; common quarterly dividend of one and three-fourths per cent, payable January 3.

Niagara Falls Power Company; regular quarterly dividend of $2 per share, payable January 16 to stock of record January 2.

Western Electric Company; an extra dividend of two per cent, payable December 31 to stock of record December 24. In addition the Company has declared a dividend of one and one-third per cent for two months ended December 1, payable December 31 to stock of record December 24. The Company is changing its fiscal year which ends November 30 to correspond with the calendar year, and the one and one-third per cent is at the regular eight per cent per annum rate, and was declared to bring this year's dividend distribution up to January 1. Previous extra distributions were stock dividends in 1906, 1903 and 1902.

CLOSING BID PRICES FOR ELECTRICAL SECURITIES ON THE LEADING EXCHANGES AS COMPARED WITH THE PREVIOUS WEEK.

NEW YORK.

	Dec. 12.	Dec. 5.
Allis-Chalmers common	8⅛	8⅛
Allis-Chalmers preferred	28½	24
Amalgamated Copper	64⅝	64¼
American Tel. & Cable	78	78
American Tel. & Tel.	141½	140
Brooklyn Rapid Transit	74⅛	74⅜
General Electric	154	151
Interborough-Metropolitan common	19½	18¾
Interborough-Metropolitan preferred	54	51¾
Kings County Electric	123	123
Mackay Companies (Postal Tel. and Cables) common	87¾	87½
Mackay Companies (Postal Tel. and Cables) preferred	74	74
Manhattan Elevated	138	137
Metropolitan Street Railway	*18	*18
New York & New Jersey Telephone	103	103
Pacific Tel. & Tel.	43⅝	42
U. S. Steel common	73⅝	73½
U. S. Steel preferred	116	115¼
Western Union	71	70⅛
Westinghouse common	67	65⅝
Westinghouse preferred	120	120

*Last price quoted.

BOSTON.

	Dec. 12.	Dec. 5.
American Tel. & Tel.	141½	139½
Edison Elec. Illuminating	280	278
General Electric	154	151
Massachusetts Electric common	18	17⅛
Massachusetts Electric preferred	84¼	85
New England Telephone	138	138¼
Western Tel. & Tel. common	16	16½
Western Tel. & Tel. preferred	86	90

PHILADELPHIA.

	Dec. 12.	Dec. 5.
American Railways	42¾	42¾
Electric Company of America	11⅝	11⅝
Electric Storage Battery common	48	47½
Electric Storage Battery preferred	48	47½
Philadelphia Electric	15¾	15½
Philadelphia Rapid Transit	18⅛	17⅞
Philadelphia Traction	83	83
Union Traction	42¾	43½

CHICAGO.

	Dec. 12.	Dec. 5.
Chicago Railways, Series 1	90½	92
Chicago Railways, Series 2	22¾	22¾
Chicago Subway	4	4
Chicago Telephone	122½	122½
Commonwealth Edison	115	115
Metropolitan Elevated common	20	19
Metropolitan Elevated preferred	65	64
National Carbon common	120	120
National Carbon preferred	118	118½

PERSONAL MENTION.

H. C. WORTHEN has been appointed general superintendent of the entire southern division of the Western Union Telegraph Company, with headquarters at Atlanta. Mr. Worthen was appointed to succeed B. F. Dillon, whose death occurred a short time ago. Mr. Worthen is a native of North Carolina, and has had considerable experience in the telegraphic service.

FLETCHER M. DURBIN, for two years manager of the Evansville & Southern Indiana Traction Company, including the local street railway company, has resigned to accept a position with J. G. White & Company of New York. The change is regarded as an advancement for Mr. Durbin, who will assume the management of the electric railways of the New York concern in this country and South America, as well as the street railway of Manila, Philippine Islands. Mr. Durbin will make the New York office his headquarters.

H. B. LOGAN, president of Dossert & Company, has been elected president of the American Oil Storage Company, a New Jersey corporation capitalized at $500,000, which has acquired the patent rights for the manufacture, sale and rentals of Keefe's patent sectional steel-flange storage tanks. Mr. Logan is well known in electrical trade circles through his connection with the successful development of Dossert solderless connectors. He will continue at the head of Dossert & Company. The New York offices of the American Oil Storage Company are at 74 Broadway.

FRED R. FARMER was recently appointed secretary of the Beardslee Chandelier Manufacturing Company, Chicago, Ill. Mr. Farmer's appointment to the secretaryship is a fitting reward for the excellent results he has accomplished during the nine years of his connection with this company. Starting in the capacity of bookkeeper, shortly after the organization of the Beardslee Company, Mr. Farmer has steadily advanced, having held a position as traveling salesman, covering territory in the central and western states and for the past five years has held the position of sales manager, each year assuming greater responsibilities. During Mr. Farmer's connection with the Beardslee Chandelier Manufacturing Company he has been instrumental in originating many features unique in the fixture industry. One of these is the issuance of a catalog each year in which gas, electric and combination fixtures are listed, all of which are kept in stock, completely assembled and ready for immediate shipment. Mr. Farmer's advancement has been due, in no small measure, to his mechanical ability, experience in this department having been gained previous to his connection with Beardslee Chandelier Manufacturing Company.

FRED R. FARMER.

JULIUS ANDRAE, founder and president of Julius Andrae & Sons, celebrated his eighty-first birthday recently by a family dinner at his home in Milwaukee.

GEORGE J. LIVER, who has for the past eight years been connected with the Metropolitan Electrical Supply Company, of Chicago, Ill., has recently been appointed sales manager of that company.

WILLIAM C. HENNING has resigned his position as president and treasurer of the Durable Wire Rope Company, of Boston, Mass., and accepted the position of secretary and treasurer of the A. Leschen & Sons Rope Company of St. Louis, Mo.

CLAUDE H. KEITH, an engineer of the Marconi Wireless Telegraph Company, arrived in New York on the Atlantic Transport Line ship *Minnehaha*. Mr. Keith is on his way to the Fiji Islands to establish three new wireless stations there.

FRANCIS J. ARMSTRONG recently entered into partnership with his father, Charles G. Armstrong, consulting engineer of New York City, under the firm name of Charles G. Armstrong & Son. Francis J. Armstrong is a graduate of the Manual Training School of the Chicago University and of the Stevens Institute of Technology. He has been engaged with his father in consulting engineering work for the past year.

FRANK L. PERRY, who for many years was connected with the editorial and business departments of the WESTERN ELECTRICIAN, and is one of the most popular men in the electrical fraternity of Chicago, has returned to his home city after establishing a most interesting record in connection with daily newspaper work in Baltimore. In June, 1910, shortly after assuming the management of the Baltimore *Sun*, and establishing an evening edition, Chas. H. Grasty, president of the A. S. Abell Company, publishers of the *Sun*, engaged Mr. Perry to investigate the advertising methods of the Chicago daily papers and to organize a classified advertising department for the *Sun*. Mr. Perry's work has been so successful that upon his completing the duties which he had assumed he was presented with a silver loving cup by Mr. Grasty. This bears Mr. Perry's monogram and the inscription "Classified Sweepstakes, June-October, 1910, C. H. G." Mr. Perry is also the possessor of a letter from Mr. Grasty which says: "Mr. Perry obtained in Chicago exactly the information wanted, and we are using it to good purpose. He has put in a separate classified advertising department for us, as a result of which we are making large gains as compared with any previous period in the history of the *Sun*. In a word, he 'made good.'" Mr. Perry's large circle of acquaintances and friends will be glad to hear of his success, and they will be pleased to know that he is at his laboratory in Chicago again.

OBITUARY.

HENRY G. CARLETON died of paralysis at Hot Springs, Ark., after a long illness. Mr. Carleton was the inventor of several electrical devices, among which were an arc lamp and an electrical lock-control system.

SAMUEL P. BABCOCK, who for the past twenty-five years has been superintendent of the repair shops of the Department of Water Supply, Gas and Electricity of New York City, died at his home in Brooklyn, December 6. He was a veteran of the Civil War and was at the time of his death sixty-four years of age.

WALTER L. PIERCE, general manager and director of the Lidgerwood Company, manufacturers of hoisting machinery, died December 10, of heart disease. Besides his connection with the Lidgerwood Company he was vice-president and treasurer of the Gorton-Lidgerwood Manufacturing Company and treasurer of the Hayward Company, manufacturers of dredging machinery. He was a member of the American Society of Civil Engineers, the Marine Engineers and Machinists clubs.

GUSTAV BYNG, founder and chairman of the General Electric Company, Ltd., of England, died recently at his residence in Hampstead, Eng., at the age of fifty-five. He has been intimately connected with the progress of the electrical industry in England, and up to the time of his death took an active interest in electrical affairs. Mr. Byng was born in Bavaria in 1855 and was educated in the Augsburg Polytechnikum, although after leaving school he went to England and made that country his home. Among his other activities he was associated with the work of development of telephony, lighting, electrical heating and cooking and the perfection of the electric meter. Mr. Byng was a member of the institution of electrical engineers and other engineering and scientific bodies.

C. E. STINSON, one of the best known telephone engineers in the country, died recently at Spartansburg, S. C. His death was very sudden and is believed to be due to heart failure, from which he had been a sufferer for several years past. Mr. Stinson was born in West Hurley, Ulster County, N. Y., in 1860, was for seventeen years with the Bell Telephone Company in Buffalo. In 1898 he went to Rochester to build and equip the Independent Telephone Company's plant there, which was the first large independent telephone plant installed in New York State and is considered one of the best in the State today. Afterwards he went to Memphis, Tenn., to reorganize and manage the telephone plant there. Recently he has been reorganizing the telephone properties of the Brailey Syndicate in Ohio and Indiana.

FRANK S. GORTON, formerly secretary and treasurer of the old Chicago Edison Company of Chicago and secretary of the Chicago Pneumatic Tool Company, died in his apartments in the Congress Hotel, Chicago, on December 12. Death resulted from heart failure following a severe attack of asthma, from which he had been suffering for some time. Mr. Gorton was born in Rochester, N. Y., in 1847, and received his education at Rochester University. In 1880 he married Miss Louise Steger of Chicago, and later came to Chicago as the treasurer of the Western Edison Company. In 1887 he helped form the Chicago Edison Company, becoming its secretary and treasurer. Mr. Gorton was prominent in club life, belonging to several organizations in Chicago and a number at Wheaton, Ill., at which place he made his home since his retirement in 1903. The funeral was held on December 14, the interment being at Lake Forest, Ill.

WILLIAM HENRY BRYAN, a well known consulting mechanical and electrical engineer of St. Louis, died suddenly of heart disease in Chicago December 6. He had recently been appointed chief engineer of the public school board of the city of Chicago. Mr. Bryan was born in Washington, Mo., August 14, 1859, was educated in Washington University, receiving the degree of M. E. in 1881. He began business life on the Missouri River steamboats, following this work from 1870-75. Following this he studied telegraphy and worked during vacations in the machine shop of the Missouri Pacific Railroad. He was later engineer with the Pond Engineering Company of St. Louis, and secretary of the Heisler Electric Light Company of that city. Since 1892 he has conducted an office as consulting, mechanical, electrical and hydraulic engineer in St. Louis, having offices at 418 and 419 Title Guarantee Building at the time of his death. Mr. Bryan was formerly smoke commissioner of the city of St. Louis and has for several years been on the Smoke Abatement Committee of the Civic League. He was president of the St. Louis Engineers Club of St. Louis and secretary for seven different terms. Mr. Bryan also held membership in the American Society of Mechanical Engineers and the American Society of Heating and Ventilating Engineers; also membership in the Mercantile Club of St. Louis and the St. Louis Railway Club. The Engineers Club of St. Louis passed resolutions of respect and condolence with the family and attended the funeral in a body.

INDUSTRIAL ITEMS.

THE MINNEAPOLIS STEEL & MACHINERY COMPANY has mailed to the trade its monthly stock list, including both the mechanical and structural departments.

THE HALLER SIGN WORKS, Chicago, Ill., recently distributed its 1911 catalog, listing signs, letters and sign accessories. A great variety of signs which have been installed by the company are illustrated.

THE G. W. ARMSTRONG COMPANY, Chicago, Ill., is mailing folders descriptive of its absolute cut-out arc-lamp hanger. An illustration and cross-section drawing show the appearance and operation of the device.

ROTH BROTHERS & COMPANY, Chicago, Ill., have distributed a number of catalogs and folders illustrating the various uses of the Roth motor. These applications include motor-driven blowers, saws, presses, laundry machines, etc.

THE ARROW ELECTRIC COMPANY, Hartford, Conn., lists in Catalog No. 9 a complete line of "Arrow E" specialties. Surface switches, sockets, receptacles, rosettes, etc., are listed and described. The catalog contains illustrations of each type of specialty.

THE MILLAR ELECTRIC COMPANY, Chicago, Ill., has prepared folders illustrating and describing the No. 100 electric toaster. These are made for both 110 and 220 volts, taking from 400 to 425 watts. All of the Company's toasters are guaranteed for a period of two years.

A. S. BROCK RUBBER COMPANY, Boston, Mass., is continuing at its office at 120 Milk Street, the sale of hard and soft rubber. The former is made up as sheets, rods, tubes, and moulded or turned specialties. The latter is supplied as packing or in moulded form.

THE NEW YORK INSULATED WIRE COMPANY, New York, N. Y., has mailed to the trade two blotters advertising Grimshaw white-core wire and Grimshaw tape. The cleanliness, high insulation, long life and flexibility of Grimshaw white-core wire are especially mentioned.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING

COMPANY has just issued its Part Catalogues Nos. 6141 and 6143. No. 6141 lists parts for Westinghouse type 306 interpole railway motor for direct-current circuits. No. 5143 lists standard metallic brushes for alternating-current and direct-current circuits.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has distributed to the trade its Bulletin No. 129 on the chloride accumulator in coal mines. The publication deals with the storage battery installation on the system of the New River & Pocahontas Consolidated Coal Company at Gentry, W. Va.

THE LATHBURY-D'OLIER COMPANY, ENGINEERS, Philadelphia, Pa., announces a merger of the interests of B. B. Lathbury, consulting engineer, and of the D'Olier Engineering Company. The Company, with its larger scope and facilities, will continue its engineering, manufacturing and contracting business.

THE COLONIAL ELECTRIC COMPANY, Warren, O., has issued an eight-page pamphlet covering prices, discounts, ordering instructions and delivery charges for Colonial incandescent lamps of all types. The pamphlet is of envelope size, and gives a mass of commercial data boiled down into compact and convenient form.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., is mailing Bulletin No. 8, covering special fixtures and accessories for Mazda lamps. Particular attention is called to the reflector sockets with flat and bowl-shaped reflectors; to street-lighting fixtures for low and high-voltage lamps, and to the series sockets for large-base lamps.

THE BALL AND WOOD COMPANY, Elizabethport, N. J., has taken a contract for furnishing and erecting for the French Worsted Company, Woonsocket, R. I., a 750-kilowatt mixed-flow Rateau-Smoot turbine and Smoot alternating-current three-phase, 60-cycle generator, with directly connected exciter, under a general contract with the Rateau Steam Regenerator Company.

THE BRILLIANT ELECTRIC COMPANY, Cleveland, O., has prepared for publicity purposes twelve blotters imprinted with advertisements of Brilliant Mazda lamps. A folder of facts concerning Brilliant Mazda automobile lamps, one on Brilliant Mazda miniature lamps and a neatly designed leaflet "With His Orders in His Cap" are also being mailed to the trade.

THE NERNST LAMP COMPANY, Pittsburg, Pa., describes in a booklet entitled "Modern Merchandising Establishments" the factory of the Higbee Company, Cleveland, O. Illustrations of various departments of the store are employed and a description of the conditions of each is given. In connection with each one of the illustrations a lamp of the style used is shown.

THE INDIANAPOLIS ELECTRIC SUPPLY COMPANY, Indianapolis, Ind., announces that it has taken over the entire property and interests of the Royse Electric Company of that city. The officers of the Company are: R. P. Obinger, president; H. E. Rasmussen, vice-president; C. E. Kennedy, secretary, and R. A. Macgregor, treasurer. A general electric jobbing business is to be carried on.

THE HEANY FIREPROOF WIRE COMPANY, York, Pa., has distributed folders in explanation of the good qualities of Heany fireproof wire in connection with compressor coils. The coils are asbestos-insulated, and after being tested showed no bad effects as a result of the extreme heat. An illustration of the cotton wound coil and an asbestos-insulated coil are shown for purposes of comparison.

THE CARLYLE JOHNSON MACHINE COMPANY, Manchester, Conn., describes in its catalog E its line of friction clutches, and shows a number of illustrations of the device. Special mention is made of clutches for cut-off coupling work for use in connection with marine motors. The list of parts is very complete and for ready reference all parts are given with reference numbers, which correspond to numbers on the sectional drawings.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, Pittsburg, Pa., has issued Circular No. 1188 on the type MW slip-ring induction motor. The circular describes a line of Westinghouse alternating current slip-ring motors designed especially for cranes, hoists and elevators. Reference is made also to suitable controlling devices and brakes; complete information regarding these auxiliary devices can be obtained from the Westinghouse Company's nearest district office.

THE BRISTOL COMPANY, Waterbury, Conn., has issued Bulletin No. 140, which, it states, covers the most complete line of recording pressure and vacuum gages ever placed on the market. The bulletin includes the original form meters only, which style has the extra-length pen arm and consequent small angle of deflection. The portable form, moisture-proof form and water-proof cases which are also furnished are listed and illustrated in the publication.

THE DICKINSON MANUFACTURING COMPANY, Springfield, Mass., makes an especial feature of its insulating materials, Stern-Bakelite and Sternoid. These substances are guaranteed to stand a temperature of 500 degrees Fahrenheit without softening. The molded material is furnished in many forms, including switch bases, coil plugs, telephone receivers, etc. Kurt R. Sternberg is connected with the company in the capacity of treasurer and general manager.

THE NOVELTY INCANDESCENT LAMP COMPANY announces that its main office has been moved from Emporium, Pa., to No. 1733 Broadway, New York City. The company's factories at Emporium and St. Marys, Pa., are still in operation and the production of both plants has been considerably increased. The Emporium factory is confined exclusively to the manufacture of carbon-filament lamps in all standard styles, while the St. Marys factory is making tungsten street series, tungsten sign lamps, and tungsten car-lighting lamps.

THE PETTINGILL-ANDREWS COMPANY, Boston, Mass., has recently published Catalog No. 14 of electrical merchandise. This supply catalog is very complete and an especial effort has been made to show a representative line of standard electrical goods, including such new material as is of practical value. In order that the Company's customers may at all times be well informed, bulletins describing new specialties will be sent out from time to time. These will serve as supplements to the catalog. The catalog is well printed and contains numerous illustrations.

HUBBARD & COMPANY, Pittsburg, Pa., has issued a new catalog devoted to descriptions and illustrations of Peirce brackets. Copies of this catalog may be secured upon request. The department organization of Hubbard & Company is as follows: Peirce Specialty Department, C. L. Peirce, Jr., manager, insulator brackets, break arms, cross-arm pins, pole seats, expansion bolts, hammer drills; Bolt and Line Material Department, C. Seyler, manager, cross arm braces, lag screws, ground rods, bolts, pole steps, guy rods, guy shims, forgings of all kinds; Shovel Department, John J. Brooks, manager, shovels, scoops, spades, telegraph spoons and shovels, ditching and drain tools; Railroad Tool and Washer Department, R. L. Mason, manager, railroad track tools, sledges, tamping bars, digging bars, picks, mattocks, grub hoes, round and square washers.

THE WESTERN ELECTRIC COMPANY has just issued its bulletin No. 5500, describing Hawthorn direct and alternating-current inclosed arc lamps. The bulletin contains twenty pages and is well illustrated with many photographs, diagrams and tables. Separate pages are devoted to direct-current multiple inclosed arc lamps, including the marine type, for 100 to 125-volt circuits; direct-current multiple inclosed arc lamps including the mill type, for 200 to 250-volt circuits; power circuit lamps, direct-current inclosed arc lamps for power circuits, alternating-current multiple inclosed arc lamps for circuits of 100 to 125 volts, 200 to 250 and 400 to 460; direct-current series inclosed arc lamps for 6.6 ampere circuits, alternating-current series inclosed arc lamps for 6.6 and 7.5 circuits, Solaris arc lamps, both alternating current and direct current, and arc-lamp accessories.

DATES AHEAD.

American Association for the Advancement of Science, and affiliated societies. Minneapolis, Minn., December 27-31.

Chicago Electric Show. Colliseum, Chicago, Ill., January 7-21.

Electrical Contractors' Association of New York State. Annual meeting, Albany, N. Y., January 16.

Minneapolis Electrical Show. Minneapolis, Minn., January 26-Feb. 4.

Iowa Electrical Association. Annual meeting, Davenport, Iowa, April 19, 20 and 21.

RECORD OF ELECTRICAL PATENTS.

Issued (United States Patent Office) December 6, 1910.

977,443. STORAGE-BATTERY PLATE. Bruce Ford, Philadelphia, Pa. Filed April 14, 1910. A lead battery plate consisting of a large number of horizontal leaves with opening clear through the plate, the leaves being held together by vertical ribs.

977,446. PENDANT SWITCH. Charles D. Gervin, New York, N. Y. Filed March 26, 1908. A push-button switch operated through a spring-controlled cam.

977,447. CUT-OUT TELEPHONE SYSTEM. Edward Gould, Spring Valley, Minn., assignor of one-fourth to Samuel C. Pattridge, one-fourth to William D. Ingalls, and one-fourth to Fay Viall, Spring Valley, Minn. Filed October 14, 1908. A lock-out system for a magneto exchange contains selecting switches permitting the sending of signals while the line is in use and indicating when it is busy.

977,452. TELEGRAPH SENDING MACHINE. Joseph Russell Jones, Port Arthur, Ontario, Canada. Filed February 9, 1910. A casing in the form of a hand-rest co-operates with the key so that turning the case in opposite directions sends dot and dash signals over the line.

977,456. RESISTANCE DEVICE. Harry Ward Leonard, Bronx-

ville, N. Y. Filed March 29, 1909. A removable resistance unit consists of a resistance ribbon provided with terminals adapted to be readily connected into or removed from the rheostat.

977,460. CONTACT-FINGER FOR ELECTRICAL CONTROLLERS AND SWITCHES. Robert Crawford Lyness, Sunderland, England. Filed June 27, 1910. Comprises a metal strip having one of its ends bent back to form a loop and a contact tip having a recess adapted to embrace the loop.

977,462. MEANS FOR EFFECTING TELEPHONIC COMMUNICATION WITHOUT CONNECTING WIRES. Harry Grindell Matthews, Gloucester, England. Filed June 18, 1910. The transmitter consists of a frame with bundles of magnetized steel wires around its periphery and a conducting wire around the frame having a source of high frequency and a transmitter in its circuit.

977,476. TROLLEY CATCHER. Francis J. Roche, Somerville, Mass. Filed November 18, 1909. A spring-actuated drum for holding the trolley wire.

977,510. EDGE SETTER AND FINISHER. Edwin N. Chandler, Brockton, Mass., assignor to Simplex Electric Heating Company, Boston, Mass. Filed March 16, 1910. A combined holder and heater mounted for vibration, consisting of a flat plate, parallel walls projecting from the rear thereof to receive the tool, and an electric resistance device mounted at the front of the holder.

977,516. MEASURING MECHANISM. Frederic A. De Lay, Ann Arbor, Mich. Filed January 11, 1909. A revolution counter is electrically connected to a clock so that the latter is automatically started when the counter is set in motion and stopped when the counter is withdrawn.

977,521. ELECTRICALLY-IGNITED BURNER. Edward J. Goldblatt, Chicago, Ill. Filed February 21, 1910. An electric gas lighter is made integral with the burner.

977,523. AUTOMATIC BALANCING DEVICE. Victor G. Gustafson, Joliet, Ill. Filed July 28, 1909. A tiltable vessel holding mercury has one contact in a depression in the bottom and a pair of contacts on opposite sides of the vessel a little above the liquid level and adapted to be connected to the circuit by the movement of the vessel.

977,536. AUTOMATIC SWITCH FOR TELEPHONE SYSTEMS. Charles Howard North, Cleveland, Ohio, assignor to North Electric Company, Cleveland, Ohio. Filed December 8, 1908. An automatic selector switch electromagnetically controlled.

977,554. ELECTRICAL EQUALIZER SYSTEM. Otto S. Schairer, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed September 3, 1907. Renewed May 20, 1910. An alternating-current distributing system contains a pair of equalizing machines adapted to run either as generator or motor and supplied from different phases of the circuit.

977,553. SOCKET SHELL AND GLOBE HOLDER FOR ELECTRIC LIGHTS. Edward S. Sanderson, Waterbury, Conn., assignor to Scovill Manufacturing Company, Waterbury, Conn. Filed March 22, 1910. Relates to a means for interlocking the holder and shell.

977,570. PROCESS OF ELECTROSTATIC MAGNETIC SEPARATION. Henry M. Sutton, Walter L. Steele and Edwin G. Steele, Dallas, Tex. Filed December 27, 1906. Consists in subjecting the mass to an interrupted static charge of one polarity while in a magnetic field, and separately collecting the separated particles.

977,571. SYSTEM OF ELECTRIC-MOTOR CONTROL. Wilbur H. Thompson, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed January 5, 1907. A single controlling means serves to interrupt the supply of energy to the hoisting motor and to temporarily reverse the motor when either of two limits is reached.

977,577. ELECTROMAGNET. Ragnar Wikander, Edgewood Park, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed August 2, 1905. Has a movable core, a load member, a pair of toggle levers, a pair of links interposed between the core and toggle levers, and a spring interposed between the toggle levers and the load member.

977,580. ELECTRIC HEATING OR COOKING APPARATUS. Theodore Abtmeyer, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed May 13, 1909. Renewed March 21, 1910. Consists of a number of resistance units each having a stamped or punched metal envelope and a frame to which the units are secured edge to edge.

977,591. CENTRIFUGAL SWITCH. Walter J. Branson, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. Filed September 8, 1908. An induction motor is provided with a centrifugal device that raises the rotor brushes after the machine has come up to a certain speed.

977,595. ELECTRICALLY-OPERATED SWITCH. Frank Chamness and John P. Kriegbaum, Huntington, Ind. Filed October 12, 1909. An electric track switch.

977,597. SYSTEM OF OPERATION FOR ALTERNATING-CURRENT MOTORS AND GENERATORS. William Cooper, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed September 3, 1907. A synchronous machine has a regulator in its full circuit that adjusts the power factor of the current supplied.

977,598. ELECTRICAL EQUALIZER SYSTEM. William Cooper, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed September 3, 1907. Renewed May 20, 1910. An amplification of the equalizer system described in No. 977,554.

977,607. ARC-LAMP ELECTRODE. George Egly, Berlin, Germany, assignor to Gebruder Siemens & Company, Lichtenberg, near Berlin, Germany. Filed September 9, 1909. A flaming-arc electrode consists of a number of cores of light-producing salts surrounded by a continuous shell of carbon, forming a wheel-like cross-sectional area.

977,616 and 977,619. TELEPHONE TRANSMITTER. Felix Gottschalk, New York, N. Y. Filed January 29, 1910, and February 24, 1910. Relate to means for mounting and tightening the diaphragm.

977,618. TELEPHONE TRANSMITTER. Felix Gottschalk, New York, N. Y. Original application filed August 11, 1910. Divided and this application filed October 1, 1910. A guard is mounted in front of the diaphragm. No mouthpiece is provided.

977,619 to 977,623 inclusive. TELEPHONE TRANSMITTER. Felix Gottschalk, New York, N. Y. Filed October 25, 1909, January 28, February 12, February 25 and March 24, 1910. These five patents cover modifications of the preceding ones, some relating to the guard, a cup-shaped diaphragm, etc.

977,625. ELECTRICALLY-HEATED DEVICE. William S. Hadaway, Jr., East Orange, N. J., assignor to Westinghouse Electric & Manufacturing Company. Filed May 1, 1909. Comprises an outer cylinder of iron, a concentric inner cylinder of brass, and a resistance element interposed between the cylinders and insulated from each.

977,626. ELECTRIC TOASTER. William S. Hadaway, Jr., East Orange, N. J., assignor to Westinghouse Electric & Manufacturing Company. Filed May 1, 1909. Renewed March 21, 1910. Consists of a supporting frame and a number of cross bars and sections of resistance ribbon supported only at their edges by, and insulated from, the bars.

977,640. SYSTEM OF OPERATION FOR DYNAMO-ELECTRIC MACHINES. Benjamin G. Lamme, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed March 15, 1906. A single-phase series railway motor has means for preventing the machine from becoming a generator of direct current.

977,641. SYSTEM FOR THE OPERATION OF DYNAMO-ELECTRIC MACHINES. Benjamin G. Lamme, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed March 15, 1906. A modification of the above, whereby the machine is compelled to develop an electromagnetic force in phase with the trolley circuit when the car coasts.

977,643. OUTLET-BOX. Ernest R. Le Manquais, Economy, Pa. Filed September 10, 1909. Relates to details of assembly.

977,645. SYSTEM OF DISTRIBUTION. Paul M. Lincoln, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed February 3, 1910. In connection with two rotaries supplying power to a direct-current three-wire circuit are two circuit-breakers on the direct-current side and one circuit-breaker on the alternating-current side of one rotary. Means are provided for opening all breakers simultaneously when a short-circuit develops on the direct-current side.

977,648. MEANS FOR PROTECTING ELECTRICAL CIRCUITS. Paul MacGahan, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. Filed January 10, 1908. Covers a system of alternating-current circuit-breakers that open the circuit on reversal of the power supply or on excess current.

977,649. PROTECTIVE DEVICE FOR ELECTRICAL CIRCUITS. Paul MacGahan, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. Filed January 10, 1908. A modification of the control means of the above.

977,653. ELECTRIC COLLECTOR FOR TURNTABLES. Laban E. Jones, Anaconda, Mont. Filed August 15, 1910. A method of supplying current to a turntable from an overhead supply.

977,657. TELEPHONE TRANSMISSION SYSTEM. Otto T. Lademan, Milwaukee, Wis. Filed September 2, 1909. A party-line system has means for varying the impedance of the receiver circuit at the same time that the transmitter circuit is closed.

977,658. TELEPHONE DESK STAND. William Leaver, Chicago, Ill., assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. Filed March 3, 1908. Relates to the method of mounting the transmitter on the stand.

977,664. CONTROLLING MEANS FOR ELECTRIC CIRCUITS. Julius K. Lux, St. Louis, Mo. Filed April 26, 1906. A quick-opening knife switch.

977,703. AUTOMATIC SPEED CONTROL. Theophilus Brown,

Worcester, Mass. Filed December 26, 1907. In combination with a speed indicator of a gasoline automobile is an electrical device retarding the ignition when the speed exceeds a certain amount.

977,711. METHOD OF ELECTRIC WELDING. James F. Craven, Pittsburg, Pa. Filed March 5, 1909. The method of welding overlapping tubular sheets consists in applying a stiffening ring inside of the overlapping portions, and then progressively pressing these portions into close contact along a line, and simultaneously therewith passing an electric current from plate to plate and thereby fusing the metal and producing the weld.

977,713. ELECTRIC CABLE. Johannes H. Cuntz, Hoboken, N. J. Filed March 20, 1901. Consists of a continuous conductor disposed helically about a supporting core so as to counteract the electrostatic capacity of the cable.

977,721. ELECTRIC BATTERY. Charles J. Everett, New York, N. Y. Filed March 6, 1905. A box containing a number of dry cells is provided with a circuit maker and breaker for cutting in additional cells.

977,752. GAS ENGINE. Edwin E. Savard and Winfred E. Jones, Rochester, N. Y. Filed September 22, 1909. A timer for the ignition circuit of a gas engine.

977,768. DYNAMO-ELECTRIC MACHINE. John B. Wiard, Lynn, Mass., assignor to General Electric Company. Filed April 27, 1910. The stator core has a large number of holes parallel to the shaft. Each end frame has a circular groove registering with the holes and connected at one point to an external pipe, so that a cooling fluid can be passed through the holes in the core.

977,774. ARC-LAMP SAFETY DEVICE. Orla F. Asbury, Charlotte, N. C., assignor of one-half to Daniel A. Tompkins, Charlotte, N. C. Filed February 8, 1909. In combination with the holder of the fixed carbon is a finger pivoted thereto to move in a vertical plane, and shiftable automatically into the path of the feeding carbon when the fixed carbon is displaced or burned beyond a predetermined limit.

977,784. ALTERNATING-CURRENT GENERATOR AND MOTOR SYSTEM. William Cooper, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Original application filed September 3, 1907. Divided and this application filed November 30, 1908. A modification of No. 977,597.

977,797. ELECTRICAL SWITCH. William P. Hammond, Passaic, N. J., assignor to Securo Manufacturing Company, Passaic, N. J. Filed February 24, 1908. The device comprises an electric switch having a series of contacts embedded in the base ,and a switch arm, turned by a knob, which engages with the contacts.

977,809. ELECTRIC CALL AND ALARM SYSTEM. George S. Loveridge, Fennville, Mich. Filed January 21, 1910. A time clock is arranged with a number of circuits which may each be set to sound an alarm at a given time.

977,810. OPERATING MEANS FOR ROTARY ELECTRIC SWITCHES. Julius K. Lux, Washington, D. C. Filed December 4, 1906. Has an operating means with a cavity adjacent its axis, a plunger in the cavity, fastening means for this plunger, and means for holding the device, which comprises a portion within the handle which is caused to yield to lock with the handle.

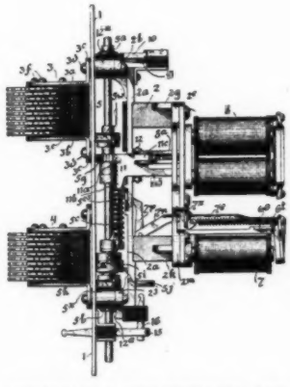
977,821. ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINE. Maurice Milch, Schenectady, N. Y., assignor to General Electric Company. Filed April 8, 1904. A rotor winding with a commutator is provided for an alternating-current machine with a fluctuating field. Brushes are provided for the commutator and means for inducing in the coils short-circuited by the brushes an electromotive force equal and opposite to the electromotive force due to the fluctuating field threading the short-circuited coils.

977,836. FIXED-POLARITY ATTACHMENT PLUG. Clarence D. Platt, Bridgeport, Conn. Filed April 25, 1910. Comprises a base, terminals carried thereby, a cover plate with part round holes having a straight side, and a plug having part round contact pins with a flat side corresponding with the straight side of a hole in the cover plate.

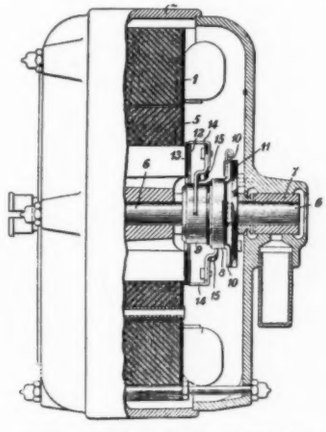
977,839. RAILWAY TRUCK. Edward D. Priest, Schenectady, N. Y., assignor to General Electric Company. Filed July 30, 1910. A railway truck includes a number of axles having driving wheels secured thereto, journal boxes on the axles between the wheels, a truck frame supported on the journal boxes, and driving motors jointly supported by journal boxes and frame.

977,870. INDUCTION COIL. John Otto Heinze, Jr., Lowell, Mass. Filed May 22, 1909. Two induction coils are removably mounted in a box.

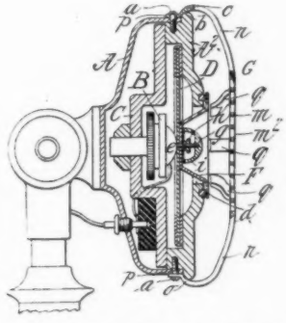
977,879. ELECTRIC TELEGRAPHY. Juzo Kajiura, Tokyo, Japan. Filed April 4, 1910. In combination with an artificial line corresponding to that portion of line cable lying between the home end and the "intermediate position" of an arrangement of self-inductances, resistances and capacities branching from the center of the balancing rheostat and adapted to imitate the rise and fall of a potential in relation to time at the "intermediate position" of line cable caused by a sending battery at the home station.



977,536.—AUTOMATIC TELEPHONE SELECTOR.



977,591.—CENTRIFUGAL SWITCH.



977,619.—TELEPHONE TRANSMITTER.

977,912. MOTOR-CONTROL SYSTEM. Harold E. White, Schenectady, N. Y., assignor to General Electric Company. Filed July 19, 1910. A motor controller has movable contact members, contact fingers, means for moving the contact fingers into an inoperative position, and means responsive to conditions in the motor circuit for holding the fingers in this inoperative position and out of engagement with the movable contact members during overload conditions in the motor circuit.

977,935. BOX FOR PACKING ELECTRIC INCANDESCENT LAMPS. Mary Isabel Cooper, Hockley, England. Filed June 12, 1909. A box is arranged with a pair of parallel rack plates holding the lamps firmly.

977,939. ELECTRIC-LAMP REFLECTOR ATTACHMENT. Henry D'Olier, Jr., Rutherford, N. J., assignor to Holophane Glass Company, New York, N. Y. Filed June 22, 1909. The reflector is attached to an incandescent lamp by means of a resilient ring member which embraces the lamp socket.

977,940 and 977,941. SHADE OR REFLECTOR ATTACHMENT. Henry D'Olier, Jr., Philadelphia, Pa., assignor to Holophane Glass Company, New York, N. Y. Filed December 8, 1909. The reflector is attached to the socket by supporting fingers.

977,947. DANGER-SIGNAL APPARATUS FOR MINES. Anton Grohs, East Pittsburg, Pa. Filed June 15, 1910. In connection with a signal apparatus for mines there is an exhaust fan for removing gas from mines, means for compressing this gas, means for detonating the gas, and electrical means for utilizing the detonation of gas to produce a signal.

977,981. TELEPHONE RECEIVER. Harve R. Stuart, Wheeling, W. Va. Filed March 21, 1908. The diaphragm has a pair of magnets each in the form of a ring having inwardly extending filleted arms, and pole pieces extending from these arms transversely to the plane of the ring, the pole pieces of one magnet being opposite the pole pieces of the other magnet.

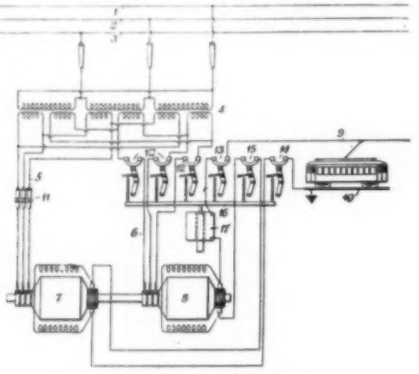
978,004. ELECTRICAL CUT-OUT. James Leslie Burton, Plainville, Conn., assignor of one-half to Frank A. Champlin, East Long Meadow, Mass. Filed February 11, 1910. A cut-out includes a fuse member provided with clips, combined with supporting clips, one set of clips being adapted to receive the other set and the respective clips being positively interlocked against accidental movement in all directions.

978,022. ELECTRICAL RESISTANCE, CONTACT AND THE LIKE. Henry Stafford Hatfield, Hovel, England. Filed December 28, 1906. Silicon is combined with a nickel-steel alloy to form a current-resisting connection.

978,030. ELECTRIC CONTACT DEVICE. Arthur Atwater Kent, Philadelphia, Pa. Filed August 16, 1905. Consists of a movable member, a tension device, a stop for limiting the movement of the member in one direction, means for advancing the member to increase the tension and separate means for releasing the member.

978,038. SYSTEM OF REGENERATIVE CONTROL FOR ELECTRIC MOTORS. Benjamin G. Lamme, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Original application filed March 15, 1906. Divided and this application filed November 8, 1907. Renewed May 20, 1910. The machine is adapted for operation either as a motor or as a generator and is provided with series-connected field and armature windings. A source of current is connected in shunt circuit to the field magnet winding when the machine is operated as a generator.

978,053. SWITCH-OPERATING MECHANISM. Elmer S. Olmsted, Louisville, Ky., assignor to Cheatham Electric Switching Device Company, Louisville, Ky. Filed July 1, 1910. Means are provided for closing the switch by closing the circuit through



977,645.—DISTRIBUTING SYSTEM.

the switch-throwing device, and also for locking the switch in the desired position.

978,062. AIR-COMPRESSING APPARATUS. Percy Russell, New York, N. Y., and Adolph W. Schramm, Riverton, N. J., assignors to Electro Dental Manufacturing Company, Philadelphia, Pa. Filed August 17, 1907. Motor, controller box and a normally closed switch are mounted as a unit. The switch is so arranged that when the belt is disengaged from the pulley the circuit is opened.

978,070. TELEPHONE TRANSMITTER. John Sparks, Kimberly, Cal. Filed March 30, 1910. A mouthpiece contains a diaphragm and a valve chest filled with fluid under pressure. Valves are so controlled by movements of the diaphragm that sounds may be reproduced.

978,075. TELEPHONE MOUTHPIECE. George R. Taylor, San Francisco, Cal. Filed September 27, 1909. The mouthpiece is so constructed as to provide an open-air chamber of considerable size.

978,079. KEYBOARD TELEGRAPH TRANSMITTER. Dana S. Troth, Oakland, Cal. Filed May 8, 1909. Renewed November 1, 1910. A keyboard telegraph transmitter has a rotatable toothed roller, means for rotating this, a plurality of toothed wheels mounted adjacent to this roller and normally out of mesh without means for meshing the toothed wheels with the toothed roller and a projecting tooth on each of the toothed wheels, adapted to lift the toothed wheels out of the mesh with the toothed roller when desired.

978,083. TELEPHONE REPEATER SYSTEM. Nathaniel G. Warth, Columbus, O. Filed July 15, 1907. Involves a combination of a divided main telephone circuit having independent induction-coil secondary windings in each division, differentially controlled repeating devices, one device for each main circuit, divided local or tertiary circuits and a primary circuit for each main circuit.

978,094. INCANDESCENT ELECTRIC LAMP. Albert A. Wilkins, Middleton, Mass., assignor of one-half to Frederick R. Campbell and Charles E. Campbell, Lynn, Mass. Filed Sept. 13, 1909. The filament is made up of sections of carbon and tungsten filaments arranged in series.

978,103. CARBONATING APPARATUS. Charles L. Bastian, Chicago, Ill. Filed November 1, 1909. Combines a carbonating tank, means for supplying gas to the tank, a pump for supplying water to the tank, an electric motor for operating the pump, an electric circuit and a switch which is opened when the water in the tank reaches a predetermined level.

978,119. LIFTING MAGNET. Arthur C. Eastwood, Cleveland, Ohio Filed May 13, 1910. Provision is made for drying the coils and for introducing insulating material between turns.

REISSUE.

13,178. CONTROLLER. Ernest Schattner, London, England, assignor to General Electric Company. Filed Sept. 12, 1910. Original No. 775,501, dated Nov. 22, 1904. A motor-starting rheostat, having a self-reducing resistance, an electromagnet, means for closing circuit through resistance and electromagnet in parallel, a contact, a switch-arm movable to short-circuit the resistance, and means whereby the electromagnet retards the movement of the switch-arm.

PATENTS THAT HAVE EXPIRED.

Following is a list of the electrical patents (issued by the United States Patent Office) that expired December 12, 1910:

510,430. TELEGRAPH OR TELEPHONE SYSTEM. Wallace R. Kirk, Kansas City, Mo.

510,457. ELECTRIC-CALL SYSTEM. Samuel Whitehall, South Bend, and Euprates W. Whitehall, Attica, Ind.

510,460. DYNAMO-ELECTRIC MACHINE. David H. Wilson, Chicago, Ill.

510,465. REGULATOR FOR DYNAMO-ELECTRIC MACHINES Louis Bell, Boston, Mass.

510,466. ELECTRIC FAN. Edwin H. Bennett, Jr., Bayonne, N. J.

510,472. DYNAMO-ELECTRIC MACHINE. Rudolf Eickemeyer, Yonkers, N. Y.

510,479. ELECTRIC LIGHT SYSTEM. Hiram Jones, Detroit, Mich.

510,486. ELECTRIC-LAMP SUPPORT. James J. Renehan, New Britain, Conn.

510,487. SYSTEM OF ELECTRIC DISTRIBUTION. Edwin W. Rice, Jr., Swampscott, Mass.

510,508. SIMULTANEOUS TELEGRAPHY AND TELEPHONY. Silas W. Holman, Boston, Mass.

510,533. ELECTRIC SWITCH. Jacob S. Gibbs, Hartford, Conn.

510,534. ROTARY-CURRENT MOTOR. Johannes H. F. Gorges, Berlin, Germany.

510,535. TELEPHONE TOLL APPARATUS. William Gray, Hartford, Conn.

510,540. PUSH BUTTON. Rudolph M. Hunter, Philaldephia, Pa.

510,596. REVERSING SWITCH FOR ELECTRIC MOTORS. John G. Germann, Erie, Pa.

510,600. SPEED-REDUCING AND POWER-MULTIPLYING HYDRAULIC GEAR FOR ELECTRIC RAILROAD CARS. William Hochhausen, Brooklyn, N. Y.

510,601. ALTERNATING-CURRENT MOTOR. William Hochhausen, Brooklyn, N. Y.

510,602. DYNAMO-ELECTRIC REGULATOR FOR AN ENGINE DRIVING A GENERATOR. Rudolph M. Hunter, Philadelphia, Pa.

510,603. POWER-APPLYING DEVICE FOR ELECTRIC MOTORS. Arthur H. Johnson, Rahway, N. J.

510,604. ELECTRIC BATTERY. Louis F. Johnson, Poughkeepsie, N. Y.

510,605. ELECTRIC-ARC LAMP. Jesse F. Kester, La Grange, Ill.

510,612. SYSTEM OF TELEGRAPHY. Charles J. Reed, Orange, N. J.

510,613. MAGNETO-ELECTRIC INDUCTION APPARATUS. Charles J. Reed, Orange, N. J.

510,634. ELECTRIC-RAILWAY CONDUIT. William R. De Voe, Shreveport, La.

510,640. ELECTRIC-CURRENT TRANSFORMER. William H. Hornberger, Elkhart, Ind.

510,646. AUTOMATIC CIRCUIT CONTROLLER. Charles L. Mayhew, Saratoga Springs, N. Y.

510,647. CONDUIT ELECTRIC RAILWAY. John P. Michieli, San Francisco, Cal.

510,661. ELECTRIC-CAR TRUCK. Charles F. Winkler, Troy, N. Y.

510,662. ELECTRIC MOTOR. Charles D. Winkler, Troy, N. Y.

510,777. APPARATUS FOR HEATING METALS ELECTRICALLY. Charles L. Coffin, Detroit, Mich.

510,850. CLOSED-CONDUIT SYSTEM FOR ELECTRIC RAILWAYS. Robert H. Elliott, Birmingham, Ala.

510,862. REGULATING PARALLEL-CIRCUITED ALTERNATING-CURRENT MACHINES. Carl Hoffmann, Berlin, Germany.

510,863. TELEPHONE-EXCHANGE SYSTEM. William W. Jacques, Newton, Mass.

11,395. ELECTRIC SNAP-SWITCH. Gerald W. Hart, Windsor, Conn.